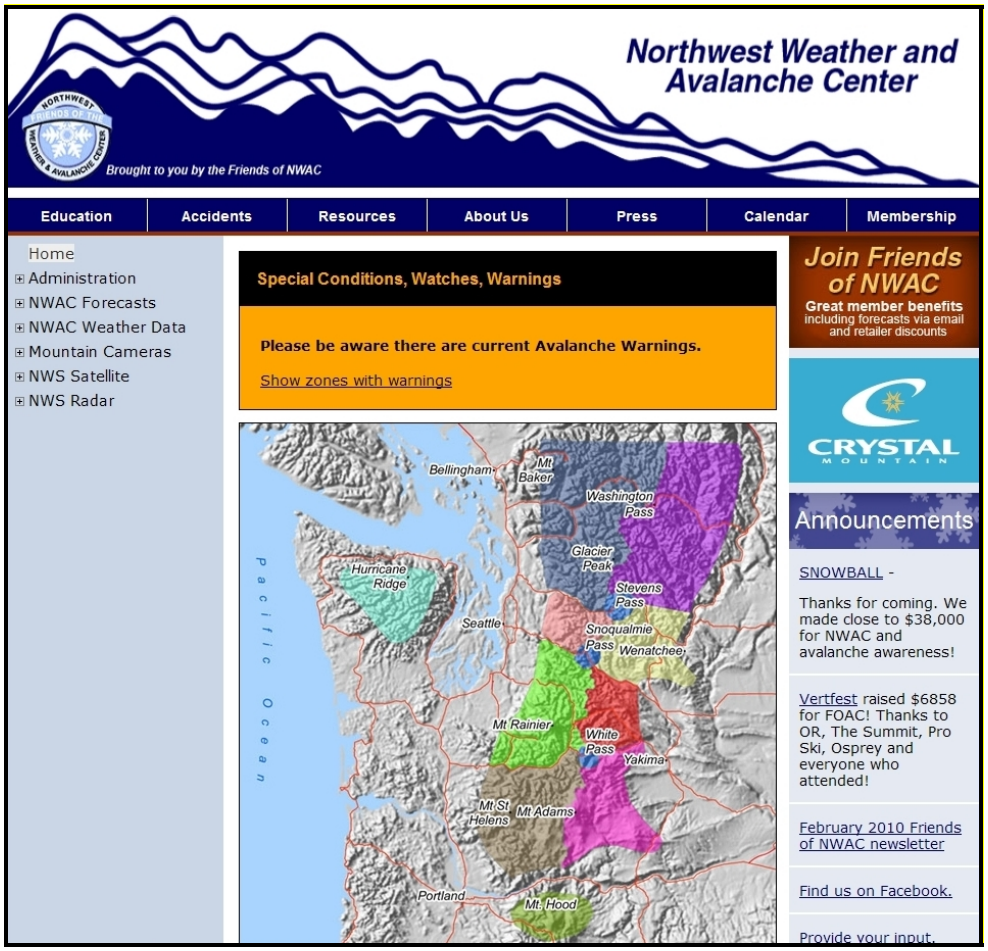
Northwest Weather & Avalanche Center



2009-2010 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, National Park Service, National Weather Service, Pacific Northwest Ski Area Association, Ski Washington, 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.

United States Department of Agriculture

Forest Service Pacific Northwest Region

Cover Photo credits:

The Friends of the Northwest Weather and Avalanche Center (FOAC) board worked long and hard (especially Jorie Wackerman and Benj Wadsworth) with Web Collective and NWAC staff to design and implement a new internet portal for NWAC forecasts, data, and avalanche, weather and snowpack related information. The site was paid for and is being administered by FOAC (who also benefit from the advertising revenues), with NWAC supplying much of the informational content. Although the new site utilized during the 2009-10 season was a huge step forward, it still only represents version 1.0 or maybe 1.1. Increased functionality of this popular web site is expected by the 2010-11 winter when users should be able to request archived forecasts or data from many past seasons via a user friendly interface. Depending on the cost for the data and forecast retrieval interface, some site specific mobile apps (mobile phones now constitute about 10% of site usage) may also be available, as well as graphical output of data, and a transition from the danger level table to danger roses in the detailed avalanche products. Among other planned enhancements, regions having similar avalanche forecasts will also be visually highlighted on the main map mouse-over, while a danger rose indicating the highest danger level in that area for the day should pop up with a mouse-over of any region, along with a daily danger trend arrow.

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A MESSAGE FROM THE DIRECTOR

After some very robust storms in late October and early November of this strong El Niño winter produced a 2-4 ft snowpack in many PNW mountain locations and an associated significant increase in avalanche danger, the NWAC started daily forecasting operation on November 10, the second earliest start for regular forecasts since NWAC's inception in 1975. The earliest start was in another El Niño driven winter, 1994-95 when NWAC began issuing special statements on November 1, and went to daily operation on November 10. In any case, the strong storms allowed many NW ski areas to open very early, which helped assuage fears typically associated with El Niño. This prompted thoughts that led to an early season poem:

> *You've heard it before, El Niño winter ahead—*
> *Some may start shrieking, and approach it with dread.*
> *"The storms will go elsewhere, dwindling rivers unfed—*
> *Reservoirs will wither, powder is dead!"*
>
> *Yet history shows, all is not lost—*
> *We've had some good winters, though at some cost.*
> *Unusual weather means unusual danger—*
> *Avalanches in places where they may be a stranger.*
> *Though overall it may be warmer and drier—*
> *The number of accidents could be higher.*
>
> *Whether driven by weather or impatient travels—*
> *Ensure that it's not your trip that unravels.*
> *Watch the snowpack as it begins to develop--*
> *Or else it's you that the slide will envelop.*

However, following this early season bounty of deep snows and November powder, the effects of a strengthening southern jetstream associated with a strong Niño event took over in late November and early December, with most winter time storm energy directed to the south of Washington and Oregon, mainly across California and eastward across the southern tier of the US. While very helpful in producing a modest rebound from a long term California drought, the results in WA and northern OR were less helpful. Highly variable freezing levels in December joined with weakening and splitting storm activity to produce significant crust-facet-surface hoar combinations that persisted in some locations well into 2010. Fortunately, the generally splitting storm activity experienced for much of January, February and March resulted in mostly minor loading of this weak snowpack structure in the NW, gradually allowing such weak layer combinations to slowly stabilize. Once again, as is common with the slowly waning effects of strong El Niños in late winter, a strong storm track took aim on the region and resulted in very low snow levels, some periods of prodigious late season powder, and generally heightened avalanche danger from late March through much of May.

Climatologically, snowdepths in most NW mountain locations as a percentage of normal reflected this seasonal weather trend quite well. Normal to well above normal depths developed in the early season, below normal depths materialized in mid-winter, and a modest rebound

developed in many areas in late March, April and into May…except for lower elevations that never completely shook off the mid-season lows. But the end result was that the 2009-10 winter did have snow and some high quality snowfall at that…even though the heart of the winter produced some disappointment. Nevertheless, most NW ski areas reported at least an average year in terms of skier visits.

Avalanche wise, the Niño winter conditions produced some unusual and rather dangerous avalanche conditions through out the mountain west. The combination of long dry and relatively cool periods interspersed with moderate snowfalls produced long lasting unstable snowpacks, particularly in the Rockies and Idaho where over 70% of the 32 US avalanche fatalities occurred. Although the NW experienced only one fatality (near Paulina Peak in the east-central Oregon Cascades, well outside of the normal NWAC forecast area), the region had many folks who were very lucky and relied on technology (cell phones), forgiving avalanches, and determined friends or rescuers to survive.

In other noteworthy news unfolding during this past season, a new web site to display and disseminate NWAC generated products and services became reality as part of a joint venture with the Friends of the Avalanche Center (FOAC) who are administering the site. The new web site…currently in its version 1.0 or possibly 1.1 iteration… was developed using Django code by Web Collective of Seattle. From the feedback received, most users seem to value the change to a more graphically driven and easier to navigate site. When upgraded to version 2.0 over this next summer, the further enhanced FOAC home for NWAC products and info should offer users an even more user-friendly and more graphical web experience as they collect weather and snowpack information to help enhance their mountain safety. Some of the 2.0 enhancements are slated to include improved site navigation, access to archived data and forecasts, and easier to use forecast and data displays, along with avalanche danger roses that show the "danger at a glance" for the day. Being administered and maintained by the FOAC, the use of on-site advertising to help support education, outreach and other efforts is ongoing and expected to continue. Meanwhile, the NWAC will continue to provide much of the data, forecast and avalanche/weather/snowpack content, all of which should be more interactive including automatically retrievable and user specified historical weather station data and archived forecasts.

Finally, despite continued support by a wide ranging cadre of core agencies and other collaborators, the common theme of funding challenges remains critical for the future viability of the NWAC. In such difficult economic times, neither federal nor state nor private monies appear readily available to completely fund the NWAC next year. Even though NWAC operations are continuously honed to the leanest program possible shy of either a shorter season or fewer days of operation each week, flat or declining funding support levels combined with gradually rising (federally mandated) salary increases for NWAC staff may make such options a reality in the future. Even while this report is underway, efforts to obtain increasing grant support (Title II/RAC) for the Center's operation are ongoing, as well as increasing fee demo monies from additional national forests that receive NWAC program benefits. However despite the best of efforts, the funding issues faced today will more than likely arise to a greater degree in the future unless a stable, long term funding solution is developed. To address this need for steady, established funding, several WA state "surcharge tax" Bills were proposed by the Washington State Legislature in years past…along with a national "Avalanche Bill S2907" (Federal Land Avalanche Protection Act of 2009) that is currently making its way through the

*US Senate (the bill was read twice and referred to the Committee on Energy and Natural Resources). While earlier efforts like this were met with varying degrees of resistance, they appealed to some and may succeed if approached in different way (which S2907 is attempting to do). Although the Mt Baker Snoqualmie National Forest and Region 6 of the Forest Service (in response to the varied funding efforts that have been made by WA state, FOAC and private groups) continue to provisionally support and administer the program while perennially sought "long term, stable" funding solutions are explored and developed, it remains uncertain as to how such annual monies will be made available in the future. —**Mark Moore, Director (May 26 2010)***

NWAC MISSION STATEMENT

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. This promotion of public safety 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 unlisted); 206-526-4666 (messages)
nwac.sew@noaa.gov

OPERATIONS SUMMARY

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

Fall Season (mid September to mid November):

- Plan for upcoming season, discuss priorities and implement changes for better operation and enhanced products.
- Prepare cooperator agreements and administer budgetary items as needed (ongoing through season)

- Attend and provide input and/or instruction at the International Snow Science Workshop (ISSW), Regional Avalanche Center Meetings, Northwest Snow and Avalanche Summit (NSAS), and National Avalanche School (NAS).
- Office preparation especially of forecasting and weather station computers.
- Weather station installation, upgrades and repairs.
- Preliminary mountain weather forecasting for ski areas and highways (WSDOT).
- Issue special public avalanche statements as needed to highlight developing avalanche danger.

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 am, 7 days a week.
- Prepare and disseminate twice daily public mountain weather forecasts and a variety of daily avalanche forecast products 7 days a week; provide updates and special statements as necessary.
- NWAC weather station repairs; ensure high quality automated hourly data via the NWAC web site.
- Gather snow pack information first hand and from others; integrate into avalanche forecasts.
- Provide avalanche awareness presentations as time and staffing allows.
- Prepare and update web site pages with accident and snowpack statistics, and other educational information on weather, snowpack and avalanche awareness.

Spring Season (mid April to mid June):

- Continue to provide mountain weather and avalanche consultations to cooperating agencies, such as WSDOT crews at Washington and Cayuse/Chinook passes.
- Issue special avalanche statements for the public as necessary.
- NWAC weather station upgrades or repairs; continue to provide quality data via the NWAC web site.
- Prepare for and host annual meeting; prepare 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 assessments of current mountain weather and avalanche observations. This information comes from the following sources:

- **Observer Network**: The duty forecaster at the NWAC receives at least daily weather and avalanche observations via telephone from professional ski patrols at many major NW ski areas, WSDOT avalanche crews, and NPS observers at Hurricane Ridge and Paradise on

Mt Rainier. Updated observations and forecasts may be exchanged several or more times/day as the situation requires.

- **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 FOAC Snowpack Information Exchange, and sources on the Internet such as Turns-All-Year.
- **NWAC Weather Stations:** The 44 NWAC weather stations at Hurricane Ridge and in the Cascade Mountains provide hourly temperature, relative humidity, wind, precipitation and snowfall information automatically via phone, radio and Internet connections.
- **National Weather Service:** NWAC staff has access to all products and expertise of the National Weather Service Seattle office, including their AWIPS (Advanced Weather Information Processing System) computer system.

Outgoing Information

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

- **Phone Consultations**: at least once daily with most ski areas, DOT avalanche crews, and observers at Hurricane Ridge and Paradise. Consultations may increase to multiple times/day during periods of rapidly changing weather and avalanche conditions.
- **Public Avalanche Forecast Hotline Phone Recordings**: in Seattle and Portland. See Product Dissemination section for more information.
- **Internet**: Visits to the NWAC web site for a variety of forecast, data and other mountain weather and avalanche information products have greatly increased over the past few years. See Product Dissemination section for more information.
- **NWS Seattle Weatherwire**: Summary NWAC avalanche forecasts are distributed to the media and commercial vendors via the NWS Weatherwire service. NWAC forecasters also regularly add an "Avalanche" section to the highly popular and nationally distributed NWS Area Forecast Discussion (AFD) product during periods of Avalanche Watches, Warnings, and Special Conditions.
- **Search and Rescue Assistance:** The NWAC provides weather and avalanche forecast assistance to County Search and Rescue teams when requested.
- **NWAC mountain weather station data:** Data for NWAC weather stations for up to the past 21 years is available upon request. Such information should be available automatically via the web site during future forecast seasons.

2009-2010 WEATHER AND AVALANCHE SUMMARY

The winter seasons weather in the Pacific Northwest for 2009-10 could be characterized by the image of a very thick book, substantially bound by impressive covers, yet filled with pages and pages of relatively fluffy material: the heavy thick binding referring to the rather impressive weather received both at the beginning and again toward the end of the season, with the bulk of the chapters constituting the core of the season being filled by rather unimpressive conditions.

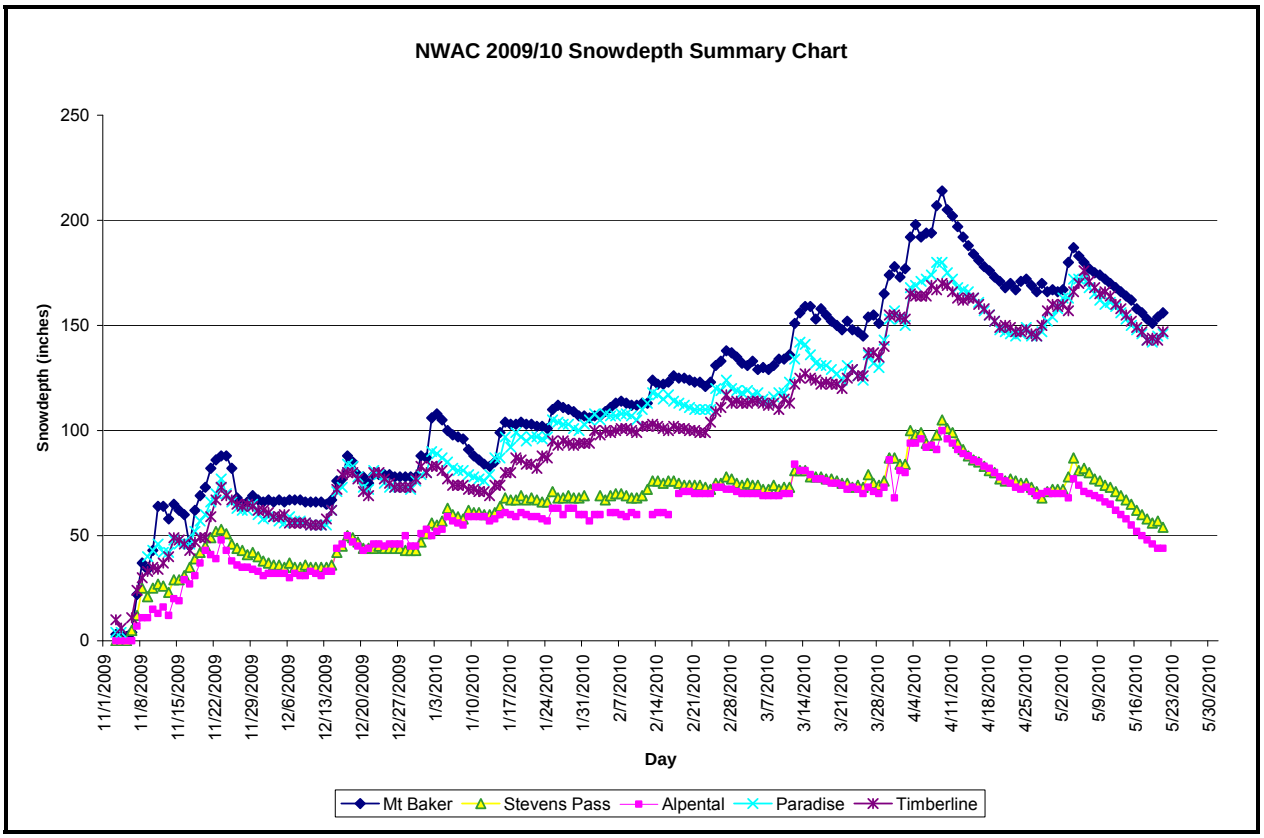


Figure 1. Pacific Northwest daily seasonal Snowdepths, 2009-10

The end result of the winter's weather was not however unexpected. Going into the season, strengthening El Niño conditions in the tropical Pacific were well advertised. The classic El Niño pattern often translates into rather mild conditions in the Pacific Northwest with the upper level flow dominated by a strong split in the Pacific westerlies. This pattern did in fact emerge during the core of the season with the strongest flow generally being directed both north of the area and south towards California and across the southern tier of the US.

The recurring split flow in the eastern North Pacific did in general produce rather benign weather in the region. Despite the rather boring weather pattern, the resultant snow pack conditions were frequently anything but. This was due in large part to the combination of numerous strong crust layers (not unusual) coupled with extended fair weather periods (very unusual). The frequent fair weather periods allowed for significant surface hoar development. Many of these layers were buried by light snowfall events to become activated following the few storm cycles that did manage to reach the area.

The season began in earnest in early November with a series of strong storms. For example the weather station NWAC maintains at the Mt Baker Ski area recorded over 20 inches of water in a nine day period between November 14th and 22nd! Little to no snow existed at this station on November 5th with the snow depth on the ground reaching 88 inches by November 23rd. This depth was not eclipsed until after the New Year. Heavy rain events to high elevations occurred within this period in late November and especially near Christmas when freezing levels topped out over 10,000 feet, (for those reading this in Colorado, that is HIGH here!) This weather produced avalanche cycles, knocked back the snow depths as well as formed strong crusts. The subsequently formed "Christmas" crust became a definitive layer for avalanches early in the New Year.

The single avalanche related fatality in the Northwest occurred outside of the NWAC forecast area on January 2, 2010 in the Paulina Peak area of central Oregon when a lone snowmobiler triggered a slide that subsequently buried and killed the rider. Fracture profiles of the slide identified a significant buried surface hoar layer that had formed above the "Christmas" crust during fair weather prior to the storm cycle preceding the accident. Similar conditions were being experienced within the area covered by daily forecasts provided by NWAC. The NWAC weather stations nearest to the accident are located in northern Oregon on Mt Hood, where 2 feet of recent snow had fallen. The fracture profile would indicate similar amounts of recent snow had accumulated there as well, creating a classic deadly scenario of recent wind slab sitting over a surface hoar layer above a smooth hard sliding surface. There were many close calls in the Washington Cascades and the Mt Hood area during this time as well.

The remainder of January was dominated by the split flow pattern, indicative of the meager snowfall amounts recorded in the area. Following the storm cycle that carried into the first few days of January, Snoqualmie Pass recorded only 34 inches of snowfall the remainder of January. February continued this pattern as the WSDOT on Snoqualmie Pass measured only 13 inches of snowfall for the entire month! While the snow was not piling up in mid-winter as is typical in this maritime climate, there were however several noteworthy fair weather periods under high pressure that provided ideal conditions for extensive surface hoar growth. Noted surface hoar layers were formed around February 10th, subsequently buried by light snowfall on the 13th , with the pattern repeating under high pressure February 18-23 with another layer buried February 24th.

The most extensive avalanche activity on these buried hoar frost layers occurred in the North Washington Cascades where guides with North Cascade Heli-Skiing were being extremely cautious due to numerous natural and triggered slides occurring on these layers. It was also the buried surface hoar layer of February 24th that was a significant component to a very close call that occurred in the Crystal Mountain backcountry on February 28th. A normally very cautious and predictably safe backcountry skier decided against his better judgment to make one last solo run in the late afternoon sunshine on a slope very familiar to him. He subsequently triggered a slab sitting on the surface hoar layer over a firm sliding surface. He was carried and wrapped around a tree mid-slope causing extensive injuries. Had it not been for his ability to get a cell phone call to the Crystal Patrol it would surely have become a fatality. His recounting of the accident is available on the NWAC web site under the Accidents tab and makes for compelling reading, highly encouraged.

While the typical winter weather in the Pacific Northwest arrived in late fall, it mostly skipped the actual winter months as a result of the El Niño conditions, only to re-emerge in spring. Beginning the last week in March the cool wet spring continued even to this writing in late May (see photo below)! As an example, from March 25th through April 9th most areas along the west slopes of the Cascades received

between 6 to over 10 feet of snow! The NWAC weather station at the base of the Mt Baker ski area received 130 inches of snowfall during this eleven day period.

Figure 2. Klawatti South Face Avalanche, North Cascades National Park - May 5, 2010, John Scurlock

During the active spring, frequent winter-like storm related avalanches occurred including more close calls. An avalanche-experienced party member in the backcountry near Snoqualmie Pass triggered, was caught and seriously injured in a slide that released on an older layer, surprising the party. In another incident, two youthful snowboarders triggered a slide in the backcountry near Mission Ridge in early April, resulting in two partial burials and one injury.

A rather remarkable accident occurred on April 10th following this extensive storm cycle. A solo hiker on a trail was traversing the base of a large slide path below Granite Mountain just west of Snoqualmie Pass when a slide was apparently triggered by snowboarders on the mountain above. The subsequent avalanche caught the hiker and completely buried him. He was able to get to his phone after a long struggle and got one call out to 911 telling dispatchers he was stranded, cold and stuck before the phone battery failed. Not knowing the precise location emergency and rescue workers made quick work to narrow the search zone based upon only two possible cell phone towers in the area. Helicopters and ground crews canvassed the Granite Mountain area before a dog team eventually located the victim four hours later. Thankfully he has made a complete recovery. Rather miraculous indeed!

The graphs below indicate that the total days with warnings or special statements were about average for the season as a whole. However, given the El Niño conditions this season, it is interesting to note how the distribution of those days was asymmetrically skewed towards the late spring. This is the only season on record when no warnings were issued for both January and February, generally the core of the season.

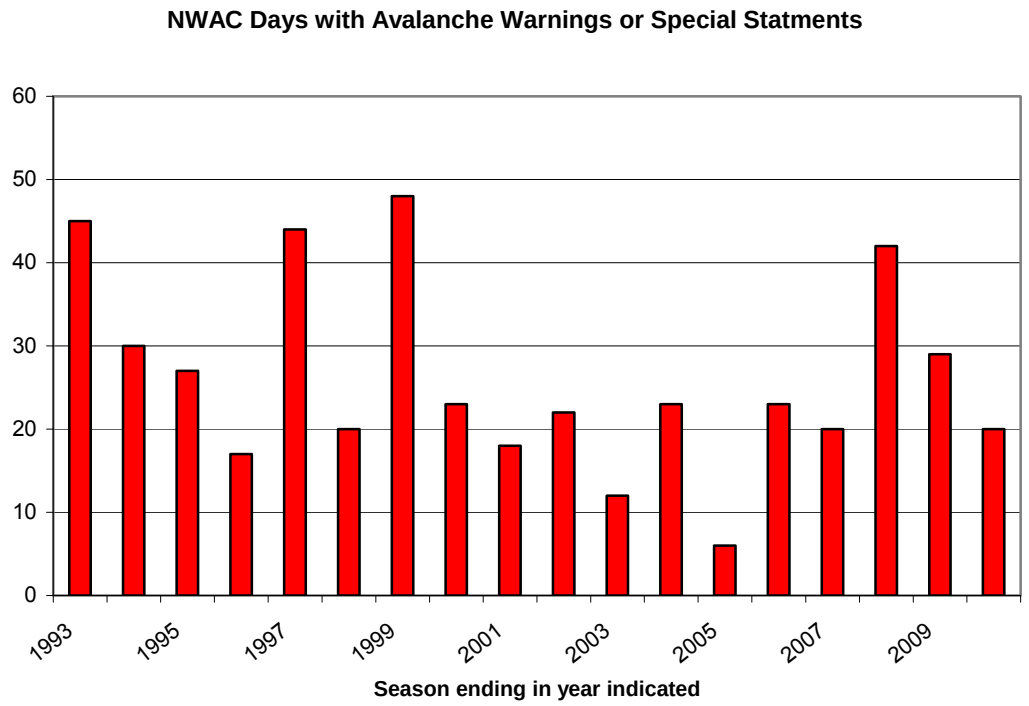


Figure 3. Days with warnings or special statements by year.

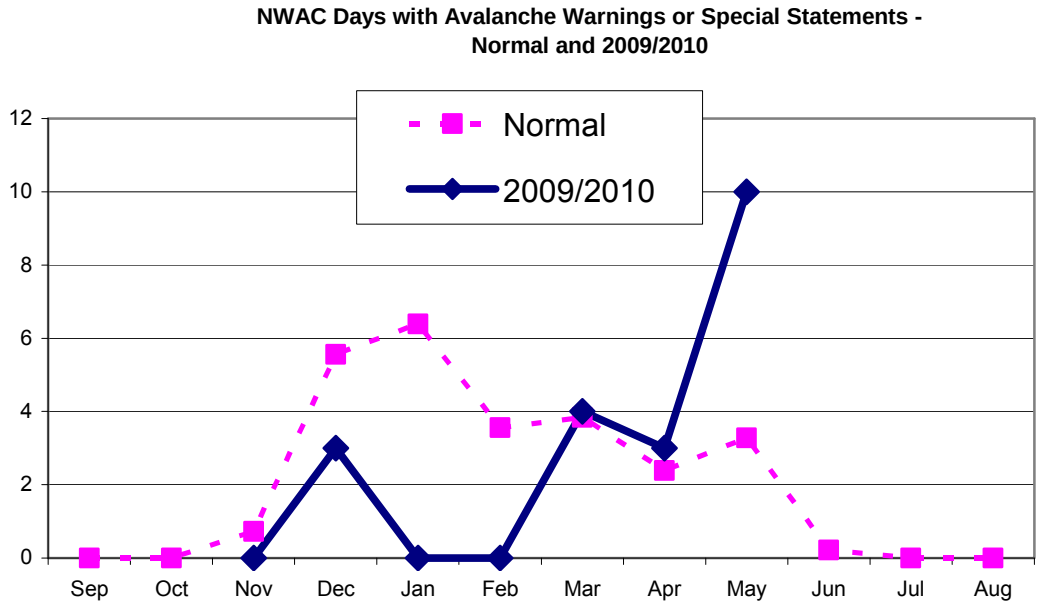
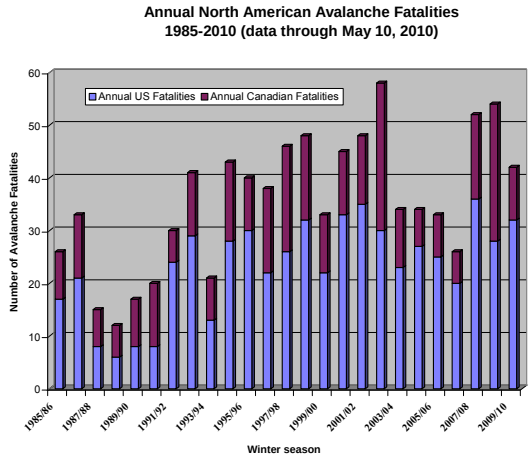


Figure 4. NWAC days with warnings or special statements by month versus normal.

AVALANCHE ACCIDENTS AND TRENDS

US And North American Statistics

Figure 5. North American Avalanche Fatalities by year, 1985-2010.



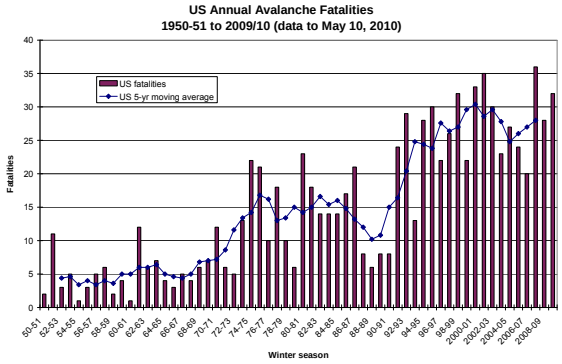
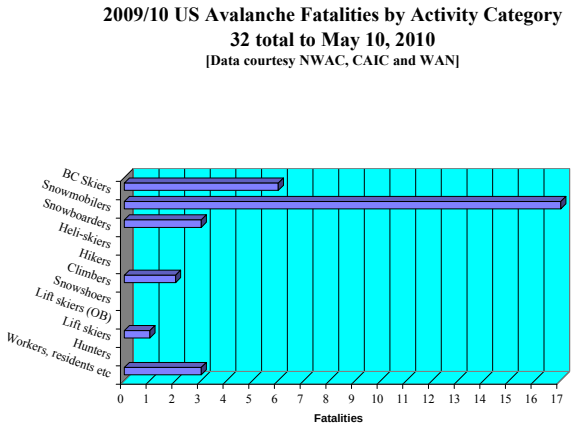


Figure 6. US annual avalanche fatalities by year, 1950-2010.

As mentioned in the *Message from the Director* the past strong El Niño winter was a challenging one avalanche-wise throughout the US. In addition to over 30 avalanche fatalities (US fatality toll through mid-May was 32, slightly above the 5-year moving average of 28), there were significant difficulties in dealing with intermittently heavy snowfall across the southern tier of the US, the Colorado Rockies and the Wasatch and Uinta Ranges of Utah, as well as periods of cold, clear weather interspersed with moderate snowfall and strong winds in the northern Rockies and Selkirks of Montana and Idaho. 2009/10 was a slightly above normal winter for North American fatalities (annual total of 42 through 5/10/10), but fortunately well shy of the modern day record of 58 set in 2002/03).

Figure 7. US avalanche fatalities by activity category, 2009-10.

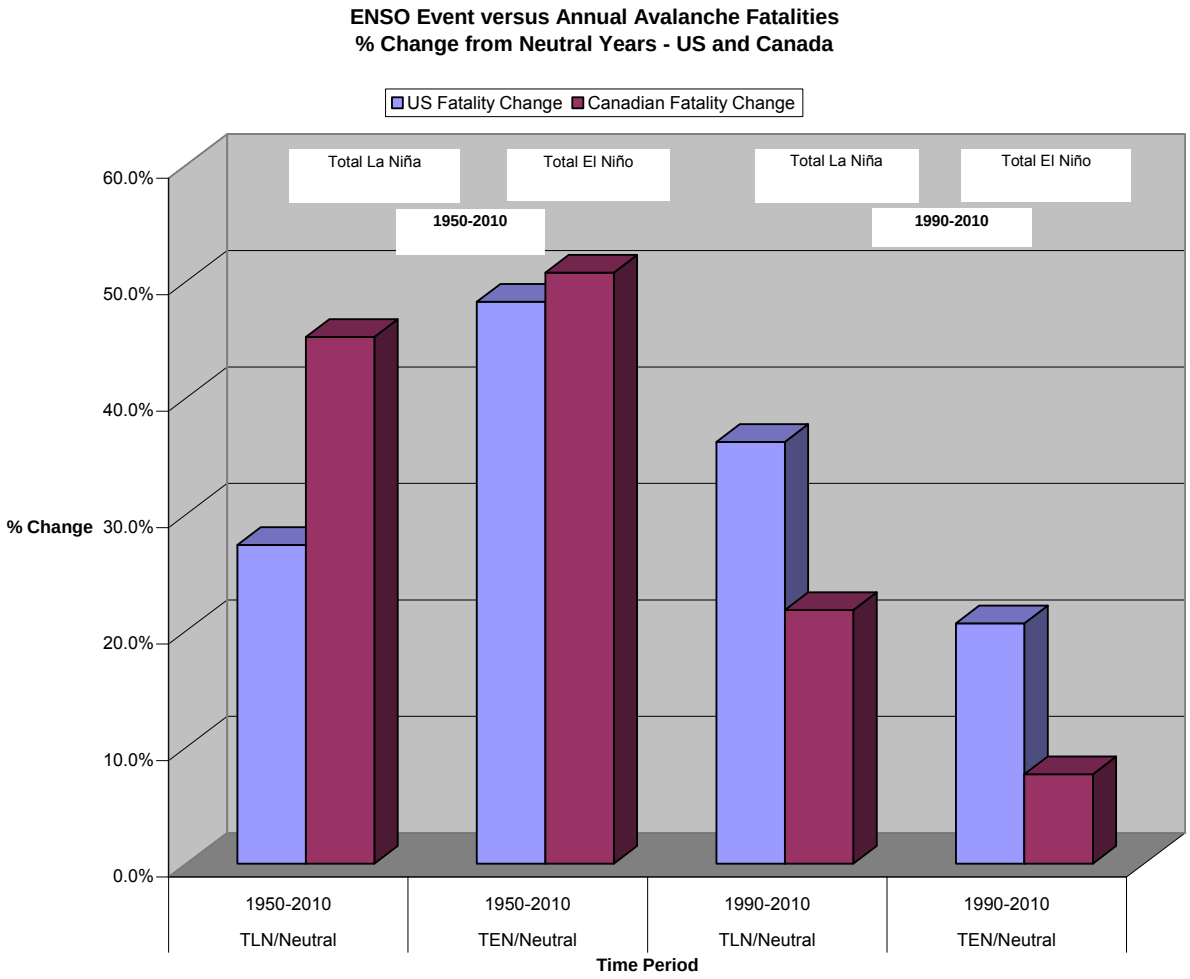


Avalanche deaths by activity category in the US were once again similar to many past winters with snowmobilers accounting for over half of the fatalities (snowmobilers accounted for 17 of 32 or 53% of US fatalities and 5 of 10 or 50% of Canadian fatalities). However, after a bad season for lift skier fatalities (in-bounds) was recorded in 2008/09, this surprising trend was not repeated this year. Note that the fatalities by activity category figure shown here do

not include an additional 10 fatalities in Canada (5 snowmobilers, 2 BC skiers and 3 heli-skiers in BC). See www.avalanche.ca for more detailed Canadian avalanche information.

In his 2008 ISSW paper, *ENSO and Avalanche Fatalities: Is there a Correlation?*, Mark Moore noted significant increases in both US and Canadian avalanche fatality totals during ENSO events (either El Niño or La Niña) over those recorded during neutral winters (non ENSO years). Avalanche fatalities during the past two winters dominated by either La Niña (2008/09) or El Niño (2009/10) have continued to indicate a possible correlation as the following updated charts show, both for the longer period of the modern avalanche era (1950-2010) and the more recent 20 years (1990-2010). Unusual or unusually persistent storm tracks (or lack thereof) can produce unusual snowpack layering (like persistent weak layers or PWLs).

Figure 8. ENSO event versus Anuual Avalanche Fatalities



If these unfamiliar layering or persistent instabilities are combined with heuristic responses to major weather changes (either prolonged clearing or prolonged storm activity) such as scarcity or abundance of snow, an increase in avalanche involvements seems to be almost inevitable. As is obvious from Figure 8, there appears to be a positive correlation between ENSO events and annual avalanche fatalities nationally for both the US and Canada. However, as indicated by

Figure 9, this response seems to vary considerably by region, with the NW actually showing a negative correlation with ENSO

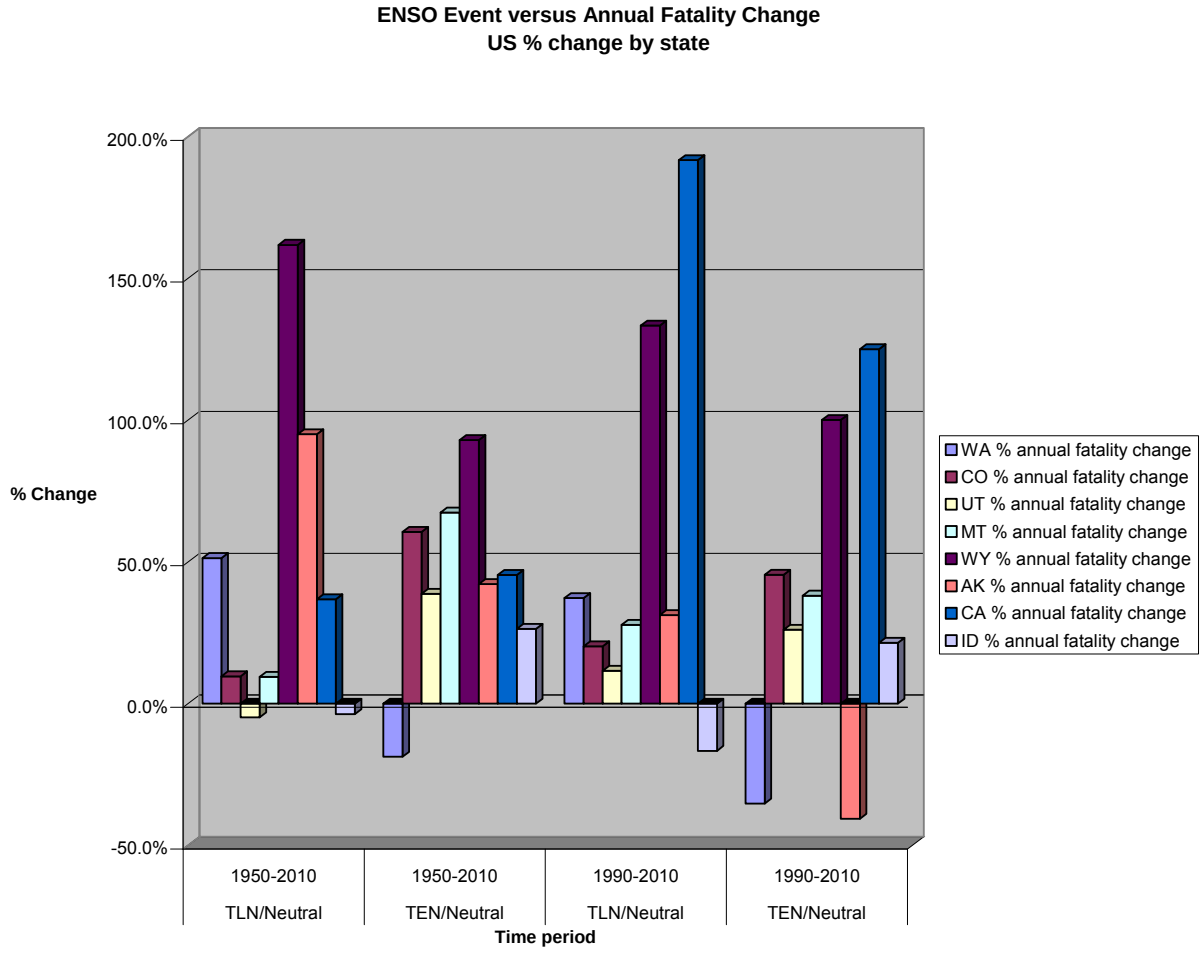


Figure 9. ENSO event versus Annual Fatality Change--US % change by state

events (however, some of this data is based on relatively few data points and should be viewed with caution). In the figures above, TLN = Total La Niña and TEN = Total El Niño.

Northwest Statistics

With a strong El Nino weakening and splitting much of the incoming storm energy for much of the mid-winter, the resulting weather produced an unusual NW snowpack that surprised many experienced travelers with survival dictated primarily by a combination of luck and cell phone access. The single Northwest avalanche fatality for the 2009/10 winter (at least thru the time of this report printing in mid-late May) was well below the 5-year moving average of 2.9 fatalities/year, with the lone fatal accident occurring well outside of the NWAC forecast area near Paulina Peak southwest of Bend, OR. A brief report on the fatal snowmobiler accident as

well as more detailed reports on some luckier survivals in other avalanche accidents can be found on the [NWAC web site accidents page](#).

Figure 10. NW avalanche fatalities by month, 1974-2010.

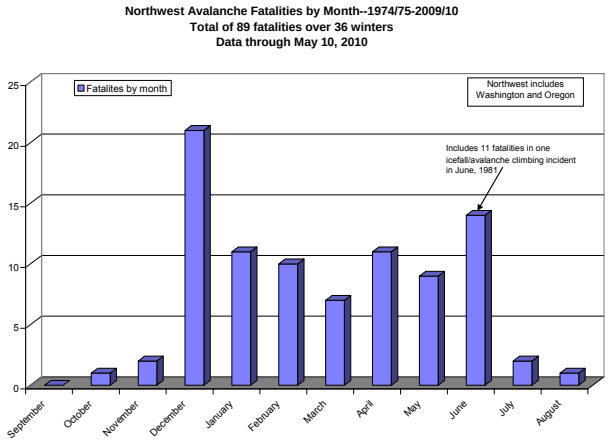
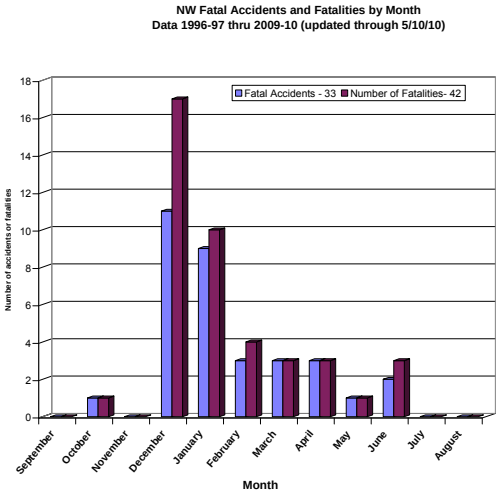


Figure 11. NW avalanche accidents and fatalities by month, 1996-2010.



From an analysis of NW avalanche fatalities by month for both the more recent term (past 14 years) and longer term (36 years), it appears that the majority of NW avalanche incidents and fatalities occur in December and January—a period often characterized by a more continental (i.e., faceted and weaker) snowpack in many NW mountain locations, one commonly associated with PWL's or persistent weak layers. Such snowpack instability/danger tends to last for a longer time (sometimes persisting into the subsequent spring in one fashion or another), and is often more difficult to discern by back country travelers as the unstable layers may be more deeply buried than casual examination may reveal. This bias toward early season incidents is well illustrated in Figures 10 and 11 which span both the more recent 14 years (Fig 11) and the longer term (Fig 10—past 36 years) as well. However, they both underscore the fact that avalanche danger should be a year round concern as fatalities and accidents occur in almost every month of the year (they do occur in every month of the year if the monthly statistics are expanded to include the whole US).

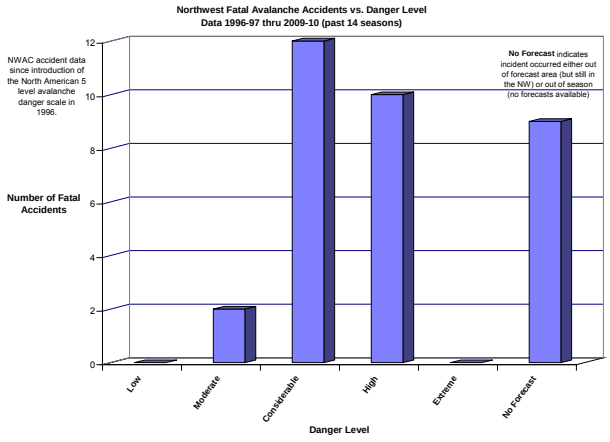


Figure 12. Northwest Fatal Avalanche Accidents by danger level, 1996-2010.

As Figure 12 shows, most of the fatal NW incidents occurred when NWAC had forecast either a considerable or high danger for the back country, although a few occurred under moderate danger conditions. A not insignificant number have also occurred either in areas not covered by the forecast or during times when the NWAC was closed (forecasters either in non-pay status or

transitioned toward summer time fire-weather work).

Also as is evident from Figure 13, while the annual avalanche toll for the NW has experienced large year to year variability over the past almost 60 years, there has been a slow increase from the early 1990's. This gradual increase may be driven by a combination of factors, including greatly increased use of the back country overall, a more "extreme" mentality among back country users and the significant growth of some "newer" and more independent users such as snowboarders and snowmobilers.

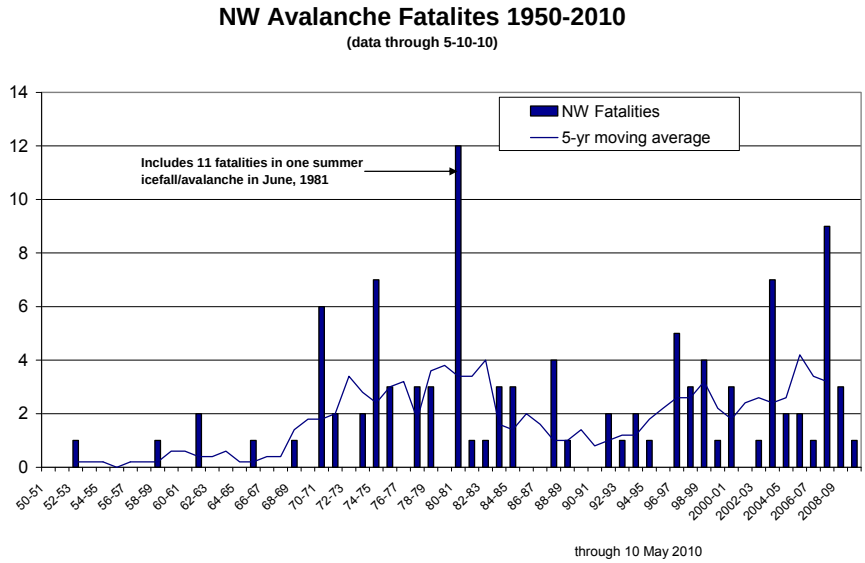


Figure 13. NW Avalanche Fatalities by season, 1950-2010.

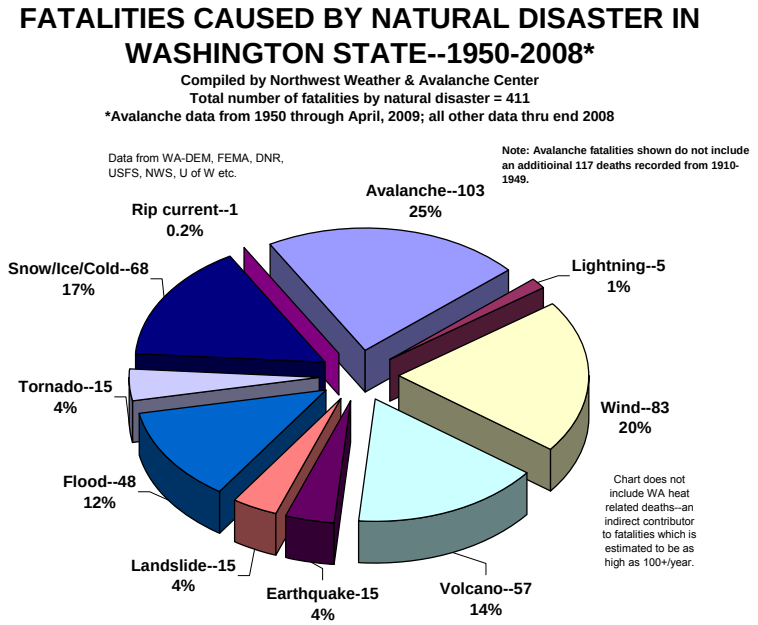
During the 25-year time period for the US fatality table by state below (Table 1), a total of 585 (55) avalanche fatalities have occurred in the US (Northwest) since 1985. This averages over 23 avalanche deaths/year in the US as a whole and about 2.2/year for Washington and Oregon combined—or about 9% of the US total since 1985. Although the 5 and 10-year running averages for the NW are up slightly from the average of 2.2/year since 1985/86 (3.1 and 2.7 respectively), this modest shorter term increase is largely due to the record setting avalanche toll of 2007/08 when 9 fatalities were recorded in the Northwest.

UNITED STATES AVALANCHE FATALITIES by STATE																											
1985/86 to 2009/10 (to May 10, 2010)																											
Winter Season																									25 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	06/07	07/08	08/09	09/10	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	5	5	4	8	143	5.7	CO
AK	0	6	2	0	1	1	2	7	2	6	8	4	3	12	5	4	11	4	3	1	4		4	3	3	96	4.0	AK
UT	5	2	0	0	1	0	5	3	1	5	2	6	2	5	2	6	5	1	4	8	4	4	3	4	4	82	3.3	UT
MT	2	1	0	0	1	0	1	1	6	3	3	1	7	2	2	7	9	4	0	3	4	6	3	6	5	77	3.1	MT
WA	2	0	4	0	0	0	2	0	0	1	0	5	2	3	1	3	0	1	7	2	2	1	9	2		47	2.0	WA
WY	2	0	0	0	0	0	2	1	1	1	3	2	1	2	0	7	2	7	1	0	2	3	4	2	4	47	1.9	WY
ID	0	1	0	0	0	0	0	2	0	0	3	3	3	0	2	0	1	3	4	3	4	1	2	3	7	42	1.7	ID
CA	2	0	0	0	1	0	2	1	0	2	0	0	1	1	0	2	1	1	1	3	1		4	3		26	1.1	CA
NH	0	0	0	0	0	1	0	0	0	0	3	0	0	0	1	0	0	2	0	0	0		1			8	0.4	NH
OR	0	0	0	1	0	0	0	1	2	0	0	0	1	1	0	0	0	0	0	0	0			1	1	8	0.3	OR
NV	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	1	0					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	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	0					1	0.0	VT
AZ	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0					1	0.0	AZ
ND	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1			1	0.0	ND
NM	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0					1	0.0	NM
TOTAL	17	21	11	6	8	8	24	29	13	28	30	22	26	32	22	33	35	30	23	27	25	20	36	28	32	586	23.4	TOTAL

Table 1. Annual US Avalanche fatalities by state, 1985-2010.

Avalanche fatalities continue to lead the way for deaths by natural disaster in Washington State, as indicated by this pie chart showing fatalities by natural disaster from 1950-2009. However, it should be noted that this chart does not include heat related deaths in Washington. While an indirect and difficult to measure statistic, it is estimated that approximately 100+ deaths/year (personal communication with Dr. Lawrence Kalkstein, Research Professor of Geography and Regional Studies, University of Miami) may be attributable to excessive heat in the Puget Sound area and perhaps twice that number statewide.

Figure 14. Fatalities caused by natural disaster in Washington State, 1950-2008.



PRODUCT DISSEMINATION AND EDUCATION

Review of recent web site traffic:

1995-2009. In the not too distant past (pre-1996), NWAC product dissemination consisted primarily of phone recordings (about 15-30,000 calls/year) and text based file dissemination via the NWS Weather Wire or an electronic BBS. However, in the more recent past (post 1996), an increasing number of NWAC products became available via the Internet, which greatly increased product access and availability. From the start of internet access to NWAC products via the Internet in 1996 (which only offered forecast access) through the winter of 2008-09, NWAC utilized the NWAC Web server log analysis package Wusage as its primary web usage analysis tool. A plot of data and forecast access to the NWAC through this software shows that Internet access to the data and forecasts greatly increased from the late 1990's through 2009. During that same time, phone recording access to avalanche forecasts decreased significantly and the mountain weather forecast recording was ended after the 2003-2004 season (analysis showed that its annual use had become minimal). The plot of data and forecast hits below (presented in last year's report) illustrates this general increase in site use.

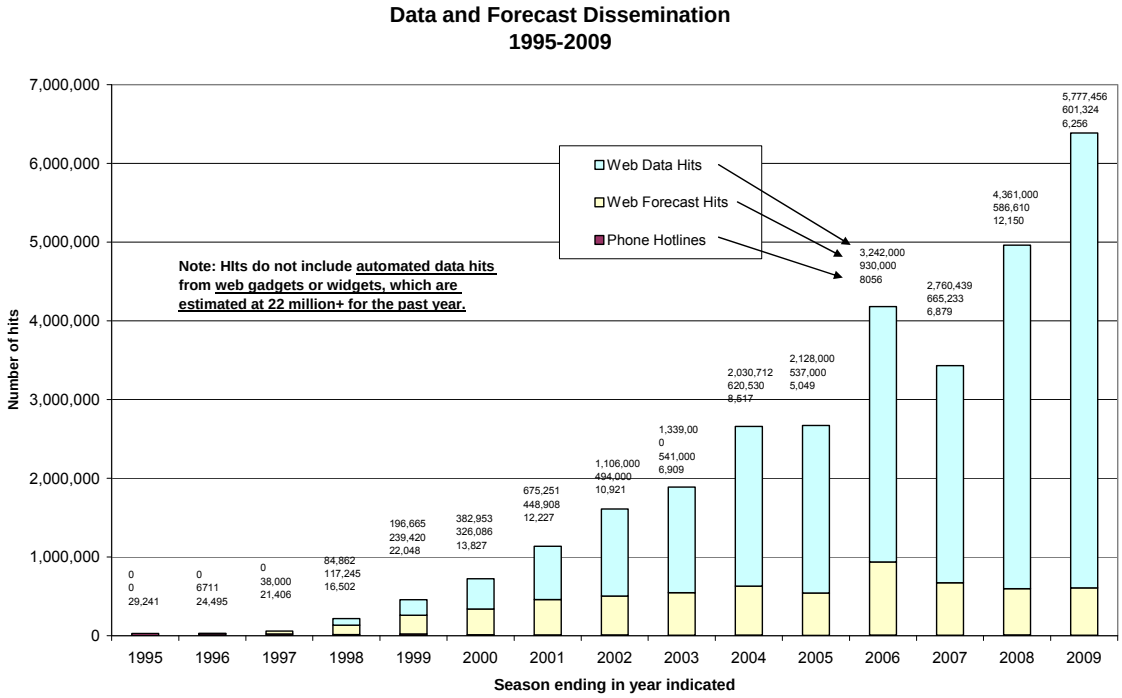


Figure 15. Data and forecast product dissemination by year, 1995-2009.

While raw data prior to this past year suggested that over 29.5 million hits were recorded on just NWAC data and forecast files alone for the period October 1, 2008 through mid-May, 2009, this remarkable increase in accesses to the web site was driven in large part by web gadgets or widgets running on remote machines that automatically updated hourly weather information from a variety of NWAC weather stations; estimates indicate that this automated data retrieval accounted for about 75% of the analyzed traffic. As a result, the total access

figures for the primary data and forecast products were adjusted downward as seen in Figure 16. However, these data widgets have now been around for several years and the increased total for 2008/09 accesses for data and forecast products were still up over 8 million from the previous season. Also, the numbers of unique visitors to the site continued to increase annually. This is a far cry from the phone-call-only days when 20-30,000 calls were received for the entire season's forecasts (both avalanche and weather). The following graph shows the dramatic increases in weekly views of NWAC web site pages by week over the past six seasons ending in the 2008-09 season (from the old Wusage package).

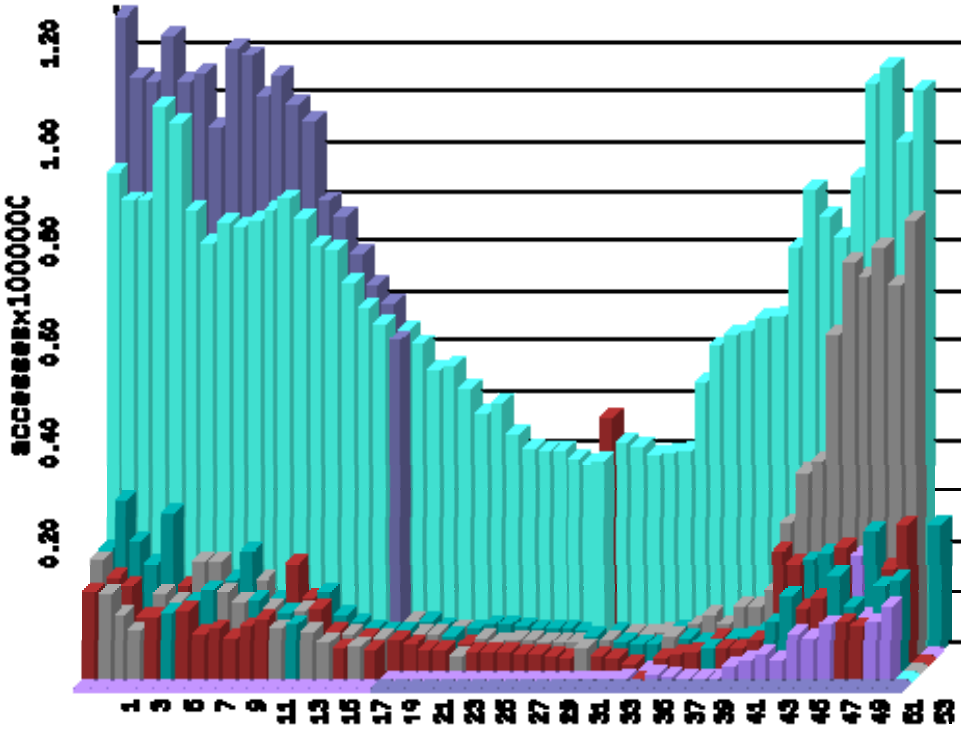


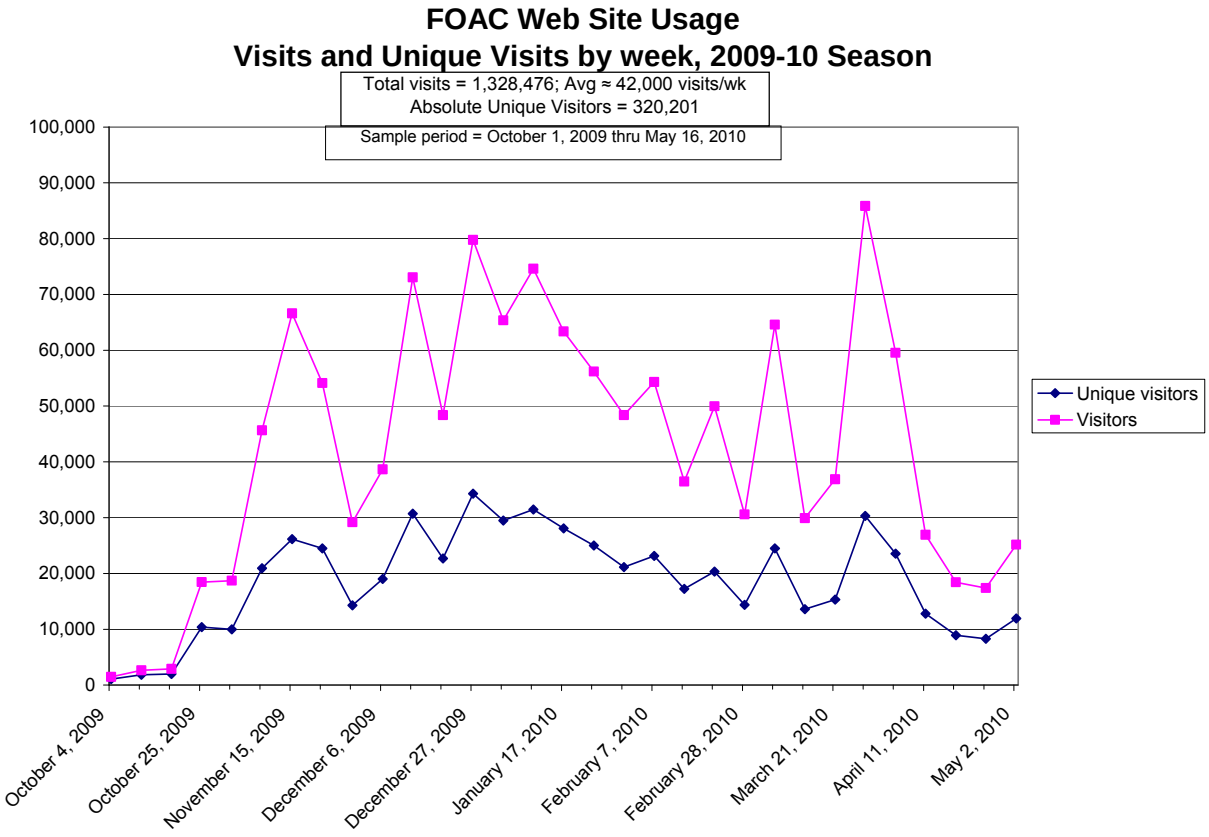
Figure 16. Annual plot of weekly page views (in millions) on NWAC web site, 2004-2009

2009-10. As of the 2009-10 winter season, the advent of the new combined FOAC-NWAC web site and its changeover to Django language coding did not allow for proper functioning of the Wusage web site tracking package. Rather, NWAC staff and the Web Collective group installed two new web site usage packages: Google Analytics and AWstats, both of which appear to filter or single out traffic from robots or worms as opposed to actual personal visits. As a result, personal visit comparisons recorded by these products for most of the web site were quite similar. Although the more detailed site web statistics provided by Google Analytics tipped the balance in its favor as the primary NWAC analytical tool for web site usage, a major drawback was that Google Analytics did not track or analyze automated web hits on the old text based data or forecast products available on the internal /data directory (this will hopefully be changed for the 2010/11 season). However, such /data file accesses were tracked by AWstats and its figures indicate up to 24 million page views and 50 million hits that are not included in the summary information that follows. As a result, the selected web site statistics given below indicate a lower end or base line for actual user traffic, especially when considering that many other web sites may download and then redisplay NWAC information

that is not part of this compilation. In any case, the figures below for the most recent winter season are primarily derived from Google Analytics, with comparison figures listed from AWstats wherever appropriate.

Selected Web Site Statistics for 2009/10:

Average weekly visitors/week = ~42,000/wk (ranging from ~29,000 to 86,000/wk)
Average weekly unique web site visits/week =~20,000/wk (ranging from about 13,000 to 35,000/wk)



Of the approximately 1,328,000 site visits, ~320,000 unique visitors initiated ~2,870,00 page views or ~2.2 page views/visit for the 2009-10 winter season from October 1, 2009 thru mid-May, 2010 (AWstats data indicates approximately 403,000 unique visitors for the same period). This site traffic was composed of a combination of direct, referring site, and search engine visits as follows:

- Direct Traffic comprised ~32% of these visits or ~432,000 visits
- Referring Sites comprised ~53% of these visits or ~701,000 visits (from over 1500 referring sites)
- Search Engines comprised ~15% of these visits or ~196,000 visits (Google comprised ~ 90% of this total, Bing ~6% and Yahoo ~3%, with others totaling about 1%)

Of the 53% of the web site traffic derived from referring sites (links to nwac.us from other web sites), the top 25 referrers were (URL, number of referred visits, percent of total referred visits):

Table 2. Top Referring sites to NWAC web site

Referrer	# referred visits	% of total referred visits
1. http://www.skicrystal.com	126,275	18.02%
2. http://www.skihood.com	120,084	17.13%
3. http://www.summitatsnoqualmie.com	58,990	8.42%
4. http://www.timberlinelodge.com	58,165	8.30%
5. http://www.wsdot.wa.gov	57,764	8.24%
6. http://www.missionridge.com	34,542	4.93%
7. http://www.skiwhitepass.com	27,157	3.87%
8. http://www.methownet.com	15,311	2.18%
9. http://www.wrh.noaa.gov	13,631	1.94%
10. http://www.skibowl.com	13,284	1.90%
11. http://www.cascadecrud.com	12,940	1.85%
12. http://www.avalanche.org	9,844	1.40%
13. http://www.mthood.info	9,299	1.33%
14. http://www.fs.fed.us	9,077	1.30%
15. http://www.alpenglow.org	7,226	1.03%
16. http://www.stevenspass.com	6,517	0.93%
17. http://www.turns-all-year.com	6,260	0.89%
18. http://www.nps.gov	6,058	0.86%
19. http://www.i90.atmos.washington.edu	5,077	0.72%
20. http://www.facebook.com	4,258	0.61%
21. http://www.google.com	4,067	0.58%
22. http://www.nwwintersportsman.com	4,042	0.58%
23. http://www.mountrainierweather.blogspot.com	3,843	0.55%
24. http://www.stevenspasspatrol.blogspot.com	3,741	0.53%
25. http://www.methow.com	3,442	0.49%

Of further note is the increasing number of visits from mobile device users. For 2009/10 mobile users totaled about 103,000 visits (or ~8% of the total site visits). To encourage and facilitate such mobile usage for accessing NWAC data and forecasts from the field or enroute to recreational or other opportunities, web site plans for this summer and fall may include development of some mobile pages (or perhaps mobile apps) for the primary devices utilized. The top five devices or operating systems and their percentage of mobile visits include: iPhone (~70%), Android (~15%), iPod (~7%), Blackberry (~5%) and Windows Mobile (2%), with the iPad and PalmOS each garnering about 0.25% of the mobile traffic.

Top Accessed Products:

As might be expected, of the approximately 2,870,000 page views recorded by Google Analytics during the past season (October through mid-May), mountain weather data and forecasts were the most highly accessed products. The following list shows the top 25 most accessed data or forecast products (not including the all text based data or forecast files available on the /data directory which were accessed millions of times, though mostly (75%) by robots or widgets:

Table 3. Top accessed products from within graphical portion of web site, 2009-10

URL for top accessed NWAC products, 2009/10 season (as measured by Google Analytics)	# accesses	% of total accesses
1. http://www.nwac.us/ (home page)	509,668	17.76%
2. http://www.nwac.us/forecast/weather/current/ (mountain weather page)	341,965	11.92%
3. http://www.nwac.us/weatherdata/mthoodmeadows/now/	296,237	10.32%
4. http://www.nwac.us/weatherdata/mtbakerskiarea/now/	145,059	5.05%
5. http://www.nwac.us/weatherdata/crystalskiarea/now/	134,908	4.70%
6. http://www.nwac.us/weatherdata/map/ (weather station map)	132,200	4.61%
7. http://www.nwac.us/weatherdata/timberlinebase/now/	90,640	3.16%
8. http://www.nwac.us/weatherdata/snoqualmiepass/now/	82,696	2.88%
9. http://www.nwac.us/weatherdata/missionridge/now/	68,270	2.38%
10. http://www.nwac.us/forecast/avalanche/current/zone/5/	66,362	2.31%
11. http://www.nwac.us/weatherdata/stevensskiarea/now/	65,991	2.30%
12. http://www.nwac.us/weatherdata/whitepass/now/	57,414	2.00%
13. http://www.nwac.us/weatherdata/alpental/now/	54,256	1.89%
14. http://www.nwac.us/weatherdata/crystalgrnvalley/now/	48,432	1.69%
15. http://www.nwac.us/weatherdata/paradise/now/	47,888	1.67%
16. http://www.nwac.us/weatherdata/stevenshwy2/now/	46,319	1.61%
17. http://www.nwac.us/weatherdata/mazama/now/	41,826	1.46%
18. http://www.nwac.us/forecast/avalanche/current/zone/13/	40,061	1.40%
19. http://www.nwac.us/forecast/avalanche/current/zone/7/	37,464	1.31%
20. http://www.nwac.us/forecast/avalanche/current/zone/3/	35,852	1.25%
21. http://www.nwac.us/forecast/avalanche/current/zone/6/	31,646	1.10%
22. http://www.nwac.us/weatherdata/washingtonpass/now/	31,415	1.09%
23. http://www.nwac.us/weatherdata/hurricaneridge/now/	31,298	1.09%
24. http://www.nwac.us/weatherdata/timberlineupper/now/	30,258	1.05%
25. http://www.nwac.us/weatherdata/skibowlgovtcamp/now/	29,674	1.03%
26. http://www.nwac.us/forecast/avalanche/current/zone/2/	22,915	0.80%
27. http://www.nwac.us/forecast/avalanche/current/zone/10/	20,782	0.72%
28. http://www.nwac.us/weatherdata/mtbakerskiarea/10day/	16,550	0.58%
29. http://www.nwac.us/accidents/	16,322	0.57%
30. http://www.nwac.us/forecast/avalanche/current/zone/9/	15,979	0.56%
31. http://www.nwac.us/weatherdata/campmuir/now/	15,522	0.54%
32. http://www.nwac.us/weatherdata/crystalskiarea/10day/	15,179	0.53%
33. http://www.nwac.us/weatherdata/snoqualmiepass/10day/	14,373	0.50%
34. http://www.nwac.us/forecast/avalanche/current/zone/1/	11,344	0.40%
35. http://www.nwac.us/weatherdata/stevensskiarea/10day/	11,317	0.39%
36. http://www.nwac.us/forecast/avalanche/current/zone/8/	11,061	0.39%
37. http://www.nwac.us/weatherdata/lakewenatchee/now/	10,355	0.36%
38. http://www.nwac.us/weatherdata/alpental/10day/	10,028	0.35%
39. http://www.nwac.us/forecast/avalanche_washington/current/	9,832	0.34%
40. http://www.nwac.us/weatherdata/mthoodmeadows/10day/	7,621	0.27%
41. http://www.nwac.us/forecast/avalanche/current/zone/11/	6,972	0.24%
42. http://www.nwac.us/weatherdata/paradise/10day/	6,162	0.21%
43. http://www.nwac.us/weatherdata/chinookpass/now/	5,504	0.19%
44. http://www.nwac.us/weatherdata/mtsthelens/now/	5,403	0.19%
45. http://www.nwac.us/resources/	5,352	0.19%
46. http://www.nwac.us/weatherdata/missionridge/10day/	5,333	0.19%
47. http://www.nwac.us/weatherdata/crystalgrnvalley/10day/	4,838	0.17%
48. http://www.nwac.us/weatherdata/whitepass/10day/	4,786	0.17%
49. http://www.nwac.us/weatherdata/timberlinebase/10day/	4,653	0.16%
50. http://www.nwac.us/weatherdata/hurricaneridge/10day/	4,649	0.16%

If these figures are compared with those provided by AWstats for the top five mountain weather data files accessed in the /data directory for last December alone, it becomes apparent how many file accesses are either missed or over-recorded (depending on your point of view) by not including visits to this important information directory:

URL of data file	File accesses
/data/OSOCMT (Crystal Mountain)	606,662
/data/OSOSNO (Snoqualmie Pass—DOT)	603,997
/data/OSOSTS (Stevens Pass—DOT)	602,187
/data/OSOMTB (Mt Baker Ski Area)	577,967
/data/OSOMSR (Mission Ridge Ski Area)	511,068

In any case, these access figures derived from use of the new web site indicate that the NWAC remains an important source of avalanche safety information for both the public and the program cooperators.

Education

The NWAC staff along with retired Forest Service volunteers and FOAC board members Roland Emetaz and Ken White once again presented a substantial number of avalanche awareness presentations over the last season as part of the normal annual educational outreach efforts. The table below presents a summary of presentations with these sessions reaching over 1700 interested attendees.

DATE	GROUP	LOCATION	ATTENDANCE	SPEAKER
15 Oct	National Avalanche Center	Leadville, CO	30	Moore
20 Oct	NW Snow and Avalanche Workshop	Redmond, WA	26	Moore, Kramer, Ferber
24 Oct	NW Snow and Avalanche Summit	REI, Seattle, WA	175	Kramer
6-8 Nov	Ski Fever	Portland, OR	350	Emetaz
13 Nov	Pilchuck High School Ski Fair	Arlington, WA	50	White
14 Nov	One BC	Portland, OR	20	Emetaz
28 Nov	Mission Ridge Benefit	Wenatchee, WA	80	Emetaz
30 Nov	Cascade Prime Timers	Portland, OR	105	Emetaz
1 Dec	ONC Ski Fair	Portland, OR	50	Emetaz
14 Dec	Volcano Rescue Team	Yacolt, WA	25	Emetaz
7 Jan	NPS ranger tour	Hurricane Ridge, WA	4	Ferber
7 Jan	Port Angeles Public Library	Port Angeles, WA	40	Ferber
8-9 Jan	Park and Recreation	Spokane, WA	75	Emetaz
10 Jan	Mt Baker beacon basin	Mt Baker Ski Area, WA	45	Moore
12 Jan	residents	Holden Village, WA	90	Emetaz
13 Jan	Vista School	NWAC, Seattle, WA	20	Ferber
19 Jan	Mountain Hardware Store	Seattle, WA	30	White
19 Jan	Mountaineers	Olympia, WA	45	Emetaz
20 Jan	Mountaineers – Climbing class	Everett, WA	24	White
21 Jan	Mountain Hardware store	Portland, OR	45	Emetaz
23 Jan	Mt St Helens Institute staff	Amboy, WA	25	Emetaz
26 Jan	REI	Hillsboro, OR	35	Emetaz
27 Jan	USFS Winter Sports Workshop	Hood River, OR	40	Ferber

28 Jan	USFS Winter Sports tour	Hood Meadows Ski Area, OR	6	Ferber
31 Jan	National Avalanche Institute	Crystal Mountain Ski Area, WA	30	Moore
9 Feb	REI	Tualatin, OR	20	Emetaz
11 Feb	Dog River Coffee	Hood River, OR	15	Emetaz
17 Feb	REI	Portland, OR	55	Emetaz
18 Feb	REI	Clackamas, OR	15	Emetaz
21 Feb	UW Hydrology seminar	Seattle, WA	15	Moore
31 Mar	Mountaineers	Tacoma, WA	50	Moore
10 Apr	Backcountry Expo	Portland, OR	30	Emetaz
22 Apr	Mountaineers – Scramble class	Everett, WA	28	White
26 Apr	NPS staff	Ashford, WA	25	Moore
27 Apr	Mountaineers – Snow Climbing class	Everett, WA	35	White
11 May	Skagit Alpine Club	Mount Vernon, WA	25	Kramer
		Total	1778	

Table 4. 2009/10 Avalanche Education efforts by NWAC & FOAC staff.

As the table below indicates, during the past 14 winter seasons these educational efforts have reached almost 26,000 people.

Table 5. NWAC avalanche education efforts by season, 1996/97 thru 2009/10.

Yr Start	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Persons	1178	1820	2440	1800	1800	2600	1486	1657	2858	1396	1868	1362	1918	1778
Total for 14 Seasons				**25,961**										

WEATHER STATION NETWORK

Major Station Work 2009-2010

Hurricane Ridge, Olympic National Park – Following a lengthy planning phase, a new site location for the weather station at Hurricane Ridge became a reality this season. The main work was accomplished jointly by park personnel and NWAC staff over several visits in the summer and early fall. The new location is co-located in a clearing where the long term manual snow measurements are recorded, with the measurement stake visible in the left foreground.

Figure 17. Newly installed Hurricane Ridge precipitation and snowdepth station

The new site has significantly more protection for the strong winds that often occur along the ridge. While the previous site was extremely poor in accurately measuring precipitation and snowdepths, the new site proved very

reliable during this first season of use. Our ultrasonic snowdepth gage generally tracked within a foot of the manual total snow stake and precipitation measurements were also highly reliable. This new site has given the NWAC forecasters an accurate real-time look at weather conditions that had previously only been inferred or often estimated from nearby station data (e.g., NRCS Waterhole site).

Crystal Mountain – New heated wind speed and direction sensors were installed in the fall with the generous help of the Crystal Mountain staff. In the past, wind sensors would routinely rime and fail to provide accurate information. The new system worked wonderfully and again gave forecasters new insights into just how windy the top of Crystal Mountain can become during storm cycles. Significantly stronger winds than in the past were routinely recorded with the new heated sensors. After much troubleshooting, the weather data at mountain top is now accessed via an internet link as opposed to a phone line.

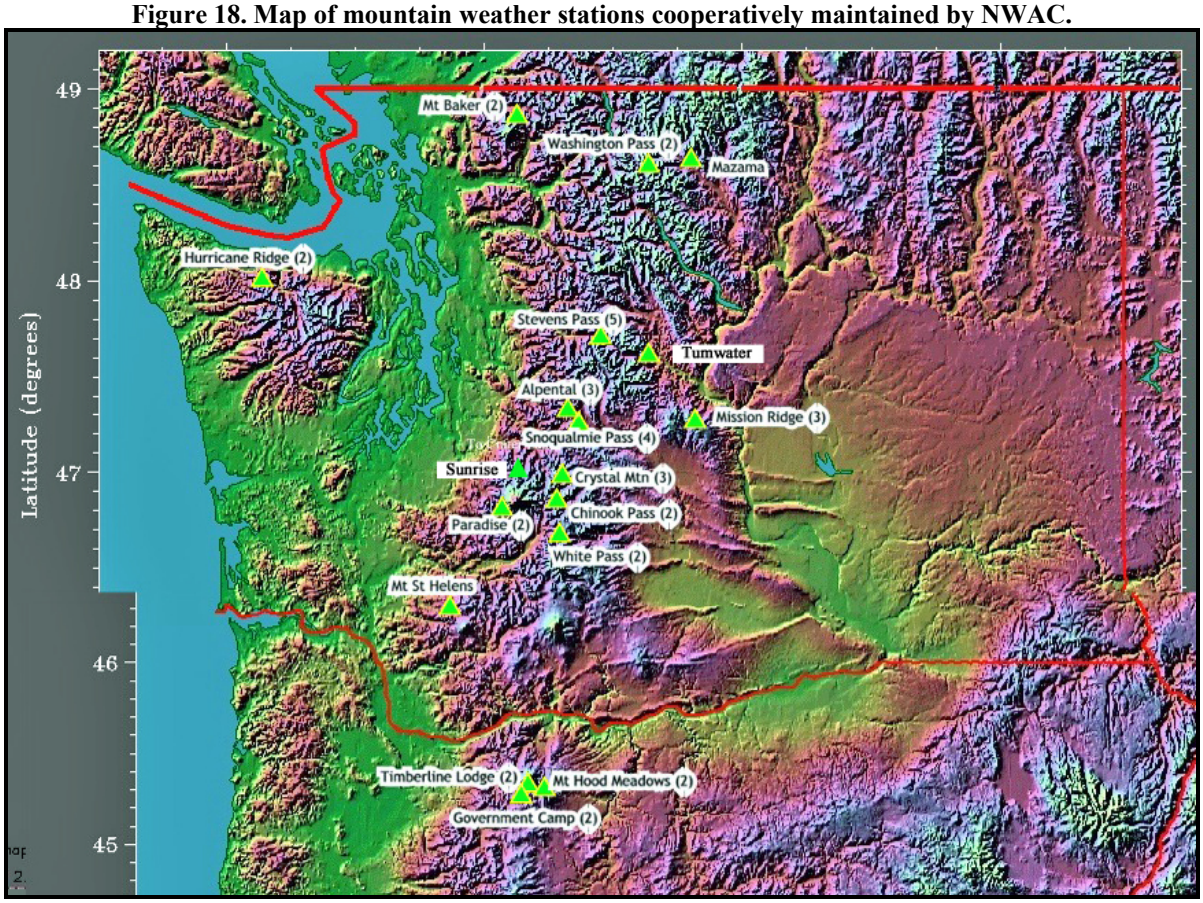
Mt Hood Meadows – New Campbell CR1000 dataloggers and internet modems were provided by Mt Hood Meadows this past season, along with the necessary internet cabling and ports for access. This has allowed for reliable and fast mountain weather data transfers to NWAC each hour via the internet.

The Internet…not just for surfing! As mentioned above, more and more Campbell Scientific dataloggers within the NWAC mountain weather network are being accessed via the internet. There are several advantages to using this method to access remote weather data. Where available, the internet provides a fast, reliable and cost effective alternative to phone lines or cell phones that were previously the only option. The hourly schedule to collect data from over 40 stations, sort, format then disseminate that data is a time consuming affair. By replacing phone line connections with internet connections a significant reduction in the time for that task can be achieved. With phone line access, the data from individual stations can be collected only one station at a time sequentially. However, the internet allows data from multiple stations to be collected simultaneously and over a significantly shorter time period. A cost savings is also achieved by eliminating recurring monthly phone charges as dedicated phone lines are no longer needed.

There are currently six stations within the NWAC network being accessed routinely via the internet with plans to add additional stations as it becomes feasible, both operationally and financially. As a result of the time savings in collecting the data, it became possible to transmit formatted data to the internet more frequently each hour. In the past the current hourly data would not routinely be available on the web site until at least 35 to 40 minutes after the hour. However, after a new schedule of data transmission was implemented this season, data from nearly half of the stations became available beginning 13 minutes after each hour with additional station data added every 12 minutes until all the data had been collected.

Along with some very important program cooperators including ski area personnel and WSDOT staff, the NWAC installs and maintains a comprehensive network of remote mountain weather sites. A scheduler PC at the office accesses, stores, formats and disseminates data automatically from the network of weather stations shown in Figure 18, which range from Hurricane Ridge in the Olympics to Mt Baker through Mt Hood in the Cascade Range. The resulting data is then made available to program cooperators and the public via our web site.

Figure 18. Map of mountain weather stations cooperatively maintained by NWAC.



Upcoming Weather Station Plans

Washington Pass Base Station Relocation – The current Washington Pass base station is surrounded by large trees and does not allow the solar panels to adequately charge batteries and maintain power to the station. Thus it has become necessary to relocate the site. The new approved site is about ¼ mile west of the current location. Plans are underway for the WSDOT to install a new weather tower this summer with NWAC staff relocating the instrumentation in the fall of 2010.

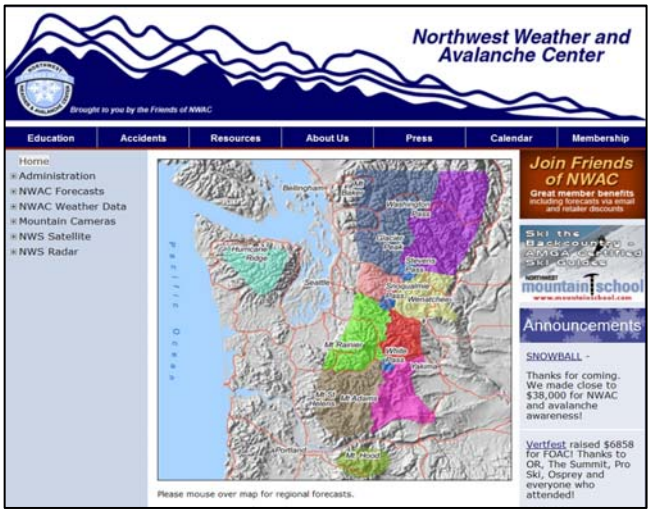
Precipitation Gage Development – Phil Taylor of Taylor Scientific (the primary engineer who has been repairing and refurbishing a variety of NWAC equipment since the early days) is currently developing a new all season precipitation gage with versions for either electric or propane heat. Presently there are no commercially available propane heated precipitation gages, and the electrically heated gages currently in use 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. We plan to test several of the new electrically heated versions of the newly designed precipitation gage (cartridge heaters immersed in an antifreeze bath supply the heat for melting snow and ice impacting an almost Frisbee like catchment surface which should minimize wind effects) as soon as the upcoming 2010/11 season.

FOAC AND OTHER PRIVATE SUPPORT

The following is a summary of shared activities of the NWAC, the Friends of the Northwest Weather and Avalanche Center and other important cooperating groups during the Fall 2009 to Spring 2010 period.

New Website

Over the summer, fall and early winter of 2009, the Friends of the NW Weather and Avalanche Center (FOAC) provided necessary funding and direction for a new collaborative web presence, interface and home for NW avalanche related information, including NWAC data, forecasts and a variety of avalanche/mountain weather information, papers, articles, videos and links. FOAC contracted with Web Collective of Seattle, who performed the web design and coding in Django, with the resulting web site hosted at Slicehost, a private VPS (virtual private server). For informational purposes, Django is a high-level Python Web framework that encourages rapid development and clean, pragmatic design. Developed four years ago by a fast-moving online-news operation, Django was designed to handle two challenges: the intensive deadlines of a newsroom and the stringent requirements of the experienced Web developers who wrote it. It allows developers to build high-performing, elegant Web applications quickly, and it is hoped that the new web site embodies some of this high performance and at least some of its elegance. Since its inception, the site has been administered by FOAC, who provided the ~$35,000 to date for its development, along with many hours of donated time and expertise of several FOAC Board members. With FOAC administering the site (and providing NWAC with a great internet venue for enhanced access to and distribution of avalanche safety services), a select group of paid advertising on the site brought in some significant revenues to FOAC (over $20,000) in this initial season.



Late last fall, FOAC and NWAC rolled out Version 1 of the new collaborative website, and it was put into operational use for the winter! As might be expected, the new site and related on-line forecast preparation resulted in a major change in the way NWAC describes the avalanche and weather situation. This resulted in some initial difficulties and modifications in preparing and disseminating the primary and enhanced weather and avalanche forecast products and a later daily issuance of the avalanche forecasts. However, the end result of a better, more detailed and reliable product through both the 2-day and 3-day time frame is considered worth the slightly later forecast issuance. By now most users and cooperators are probably familiar with the new face to the NWAC. Version 2 upgrades planned for the Summer and Fall of 2010 will also be

funded by FOAC with Web Collective performing the programming. The additional approximately $25-30,000 required for site enhancements and upgrades should allow for:

- Search features including access to archived weather data and forecasts; this should allow for easier site navigation as well
- Highlighted regions showing zones having similar forecasts with forecast map mouseover
- Popup of daily danger rose graphic and trend with forecast map mouseover
- Transition to daily danger rose graphic (aspect octants and elevational danger level rings) from current elevation only danger graphic
- Closer integration of mountain weather data plotting features with web site
- Integration of the popular Snow and Avalanche Information Exchange into the web site (with direct user input planned)
- Preparation of a mobile page or pages for easier and faster access to key products

NW Snow and Avalanche Summit (NSAS)

The 3rd annual educational and avalanche information summit was held on 24 October, 2009 at

the Seattle REI Flagship Store, with REI donating the venue free of charge, and planning, agenda and administration primarily handled by Michael Jackson and friends of the Alpine Safety Awareness Program (ASAP). The meeting (NSAS) is a professional development seminar for avalanche workers, and a continuing education opportunity for recreationalists. NSAS is intended for ski patrollers, forecasters, ski guides, search and rescue teams, as well as any number of other occupations or recreations that occur on and around snow. The content of NSAS is relevant to professionals and recreationalists alike. Attendance at this last year's NSAS was robust, with some 200 folks treated to many interesting and informative talks as indicated in the agenda below.

NORTHWEST SNOW AND AVALANCHE SUMMIT 2009
"RISK MANAGEMENT IN THE AVALANCHE INDUSTRY"
October 24, REI Flagship Store, Seattle

8:30-8:45	Steve Christie, BCA, Host	Welcome
8:45-9:30	Kenny Kramer, NWAC	Forecaster Dangers in interpreting danger level; a matter of scale
9:30-10:15	Colin Zacharias, ACMG/AMGA, AIARE	Snowpack Tests: Recent research and a guide's practical approach
10:45-11:30	Simon Trautman, CAIC	A Conceptual Framework for the Wet Snow System
11:30-12:15	Thomas Exner, ACMG, Scientist	Deep Slab Instabilities
1:45-2:30	Greg Johnson, CAAT	The Avalanche Terrain Exposure Scale - An Introduction
2:30-3:15	Ted Steiner, BNSF	Complexities of a modern forecasting program
3:45-4:30	Mike Stanford, WSDOT	Management of an Auto-Feed
4:30-5:00	Rob Gibson, Snoqualmie Pass Patrol Director	Lines in the snow - communication between backcountry enthusiast's and regional avalanche control programs

Table 6. Northwest Snow and Avalanche Summit agenda

Preparations for the 4th annual NSAS event are well underway with another very interesting and exciting slate of guest speakers scheduled.

Northwest Snow and Avalanche Workshop (NSAW)

In order to help promote better understanding and usage of NWAC forecasts and mountain weather in general, the NWAC staff in conjunction with the American Avalanche Association (AAA) and Central Washington University (via the excellent efforts of Dr. Charlie Rubin at CWU) offered a no-cost, one-day mountain weather workshop on September 19th, 2009. The winter weather skills workshop focused on fundamental weather theory essential to understanding forecasts and Internet based weather resources. The course was considered very helpful for anyone interested in learning about weather forecasting, with the skills and knowledge taught in the introductory course hopefully providing for better current understanding of the often complex relationship between weather and avalanches as well as acting as a base of knowledge for a future Advanced Weather Skills workshop.

As indicated in the course outline below, the morning session covered basic meteorology applied to Pacific Northwest winter weather. The afternoon session focused on how to best utilize publically available weather products to tailor a "now" forecast for a local mountain area. It was the intent that students learn how to interpret a basic set of weather maps along with associated satellite and radar imagery to produce a "now" weather forecast for the Washington Cascades. With this inaugural offering, the workshop was limited to 24 participants and primarily designed for professional avalanche workers and advanced recreational users, although formal meteorological education was not a prerequisite. Wireless internet access was provided and all participants were encouraged to bring a laptop. The class convened in downtown Redmond at the L. E. Scarr Resource Center, who provided the venue to the AAA non profit sponsor for a very modest fee. Instructors included all of the NWAC forecast staff including Mark Moore, Kenny Kramer and Garth Ferber, with Dr. Charlie Rubin kindly providing all of the workshop administration and logistics.

NSAW Agenda—Fall 2009

8:30 – 8:45 Check-in

8:45 – 9:00 Introductions

9:00 – 12:00 Morning session – Basic Meteorology

- **9:00 – 9:50 Meteorology Basics –** Moore
  - Heat Engine Earth (a balancing act)
    - Winds and Global circulation
      - From the Tropics to the Poles (and back)
    - Temperature and pressure fundamentals
    - Moisture
  - Upper Level Flow Patterns and the Jetstream
    - Ridges and Troughs
      - Surface feedback
    - Variations
      - Long wave, short wave features
      - Closed and cutoff highs and lows
      - Blocking features (Rex, Omega, cols)
      - Other variables
        - ENSO, AO, PDO, MJO

- **10:00 – 10:50 Surface Weather** – Moore
  - Surface features and development
    - Air masses, High and Low Pressure
    - Frontal structure

        - Precipitation
    - Interaction of Air and Land
        - Land, air and ocean interface
        - Topography
            - Wind effects
                - Diurnal winds (upslope, upvalley, etc)
            - Precipitation effects (synoptic vs. local)
                - Lift, convergence, channeling, blocking
            - Temperature effects
                - Inversions, wind flow reversal

- **11:00 – 11:50 Weather Models and Reality** – Moore
    - Maps and Models
        - Variable and Variations
        - Ensembles and Spaghetti plots
    - Tracking Reality
        - Satellite, Radar and Surface Observations

12:00-1:00 LUNCH BREAK

1:00-4:30 Afternoon session—Operational Forecasting

- **1:00-2:30 Forecast Interpretation**—Kramer, Ferber and Moore
    - Case Examples
        - Decoding Weather Forecasts
    - Short term, long term and seasonal forecasting

- **2:30-3:00 Break**

- **3:00-4:30 Operational Forecasts**—Ferber, Kramer and Moore
    - Preparing a short term forecast (mountain vs. flatlands, local vs. synoptic)
        - Getting it right now; extending the present
    - Planning for the longer term
        - Trends, Persistence and Patterns

- **4:30-END Workshop Wrap**—Moore, Ferber & Kramer

Snowbash

What more can be said about Snowbash other than it normally heralds the arrival of winter in the NW, or at least increasingly positive wintertime thoughts. It was the umpteenth annual loud, beer drinking, raffle raising, blue grass festival at the good ole Tractor Tavern in Ballard—primarily held to raise the profile of NWAC, have folks start to think about avalanches, and to raise funds for the FOAC. All of these goals seemed to be met by this gathering of "friends in snow".

Vertfest

Outdoor Research, The Summit at Snoqualmie, Pro Guiding Service, and Osprey Packs were all excited to present the 4th Annual Vertfest Randonee Rally. Vertfest is billed as the Northwest's mid-winter celebration of backcountry culture and a chance to test participant's stamina in a fun uphill /downhill ski race. The event was hosted at Alpental Ski Area on

4th Annual Outdoor Research
VERTFEST
a celebration of backcountry VertiCulture

Saturday, March 6th, 2010 with all proceeds from the event slated to benefit the FOAC. Over 100+ racers convened at Alpental for the event, which also included a rescue companion clinic offered to help build snow-safety know-how. Overall, Vertfest raised almost $7,000 for the FOAC!

Snowball

This spring's second annual end-of-the-season celebration and fundraiser for the Friends of the Northwest Weather and Avalanche Center was held at St. Demetrios Hall in the Montlake neighborhood of Seattle on April 16, 2010. Just over 200 friends and familiar faces gathered for this evening of live and silent auctions, good camaraderie, excellent wine, and a delicious dinner…and all for a great cause! It is estimated that the event brought in close to $38,000 for the FOAC, though with expenses the net for FOAC was somewhat less. The great artwork shown in the on-line flyer here was also pictured on Snowball glasses, which were made available to all attendees

NWAC BUDGET AND FUTURE

With both the federal and state economies continuing to wallow in rather dire straits during both the recent past and the present, future stable financial and operational future of the NWAC remains uncertain and rather elusive. However, it is difficult to understand how the viability of such a popular and important program remains so tentative in light of so many positive developments over the past few years. Such developments have included (on-line reference locations for several of the reports listed below have changed since a similar listing was distributed in the 2009 Annual Report and these are re-listed below with corrected links):

- introduction of a national "Avalanche Bill S2907" (Federal Land Avalanche Protection Act of 2009) that is currently making its way through the US Senate (as of mid-May, the bill was read twice and is currently under debate in the Committee on Energy and Natural Resources);
- prior passage of Washington State Senate Bill (SSB 5219) in 2007. This bill's purpose was to establish recommendations and a plan to establish the necessary framework and support structure "*to ensure that the Northwest Weather and Avalanche Center program has the resources to continue operating at its current level of service into the future*" (Sec 2(4) of SSB5219).,
- many positive results and findings about the critical nature of the NWAC program were contained in several very positive reports and analyses that resulted from the passage of SSB 5219. These included:
    - Berk and Associates Final Report—*Benefit Assessment and Economic Impact Analysis for the Northwest Weather and Avalanche Center, December 1, 2008*,

    - Consultant Knox William's Final *Report on the Northwest Weather and Avalanche Center (January, 2008)*
    - The WSPRC's final report on the NWAC, *Final Report to the Washington State Legislature On The Northwest Weather and Avalanche Center Pursuant to SSB 5219 (Chapter 141 Laws of 2007)*
- increased commitment from the state toward the Avalanche Center through Supplemental Budget monies during the past state biennium of 2008 and 2009 ($58,000 in FY08 and $73,000 in FY09),
- increased voluntary donations toward NWAC operation by a variety of private groups, including ski areas, professional ski patrols, ski schools, outfitting guides, local and national companies and others
- efforts by the Washington State Legislature to pass a new bill (SSB 5596) that was introduced to help ensure future stable funding of the NWAC through a small ($2.00) surcharge on Washington snowmobile registrations and Snowpark permits. (While constituent resistance to "being unfairly targeted" by this surcharge caused the related bill to expire in committee, it may be possible to re-energize this bill or some similar legislation in the future if the bill is expanded to incorporate more BC recreational groups, and if the affected group(s) are approached prior to the bill being released).The content of SSB 5596 was included in the NWAC Final Report for 2008/09 and is not reproduced here.

While the many positive conclusions in the Berk and Associates Key Findings Report were outlined in the 2009 Annual Report, they are significant and are again reproduced below for informational purposes:

- *NWAC saves lives by forecasting, tracking, and reporting weather and avalanche*
- *conditions.*
- *Historical avalanche fatality data suggest NWAC saves between two and nine lives per year.*
- *How much should be invested to save a life? The U.S. Department of Transportation pegs the value of a statistical life between $3.2 million to $8.4 million.*
- *Using U.S. DOT guidelines, lives saved by NWAC translate to annual economic benefits ranging from $6.4 million to more than $75 million.*

The conclusions reached in this report continue to be quite compelling and refer to the *Important Tangible Benefits* and *Broader Fiscal and Economic Impacts* of the program:

- *NWAC saves between two and nine lives per year.*
- *NWAC makes the backcountry more accessible and enjoyable.*
- *NWAC improves the efficiency of enterprises that operate in the backcountry.*
- *Conservative estimates of NWAC's benefits are at least $7.5 million annually. More likely benefits range from $20 million to $79 million annually. Given an annual budget of $340,000, this translates to an annual return on investment of at least two thousand percent.*
- *NWAC brings revenue streams and economic activity to rural areas of Washington State.*
- *NWAC increases the overall competitiveness of Washington State.*

These key points are echoed in the WSPRC Final Report which states that the NWAC:

- *is an integral part of the state's public-safety infrastructure for winter travel and recreation*
- *provides mountain weather and avalanche forecasts, special watches and warnings, hourly mountain weather data, awareness classes and related information to the general public and to avalanche safety personnel. These life-safety services also foster economic development by stimulating tourism, ensuring freight and passenger mobility through mountain passes, and leveraging the state's natural resources into a competitive advantage for corporate relocation and retention*

While the key findings listed above allude to the importance and great return on investment for the NWAC, they do not address what is needed to keep the Avalanche Center whole and viable in the future. At least one approach to the necessary framework for keeping the Avalanche Center alive in the future may be contained within consultant Knox Williams' report which states:

> *The avalanche centers that are sustainable will have these traits:*
> *• A budget spread over many committed partners for stable funding*
> *• Strong community awareness, use, and support of the service*
> *• A staff of respected and well-spoken professionals*
> *• Products and services that timely, accurate, clear, concise, and user-friendly so that users get what they need*
> *• A strong brand name, earned via reputation, advertising, and word of mouth*
> *• A good business/operations plan*
> *• An innovative entrepreneurial strategy*
> *• An exciting website*

It is strongly believed that forecast staff at the NWAC have made considerable effort to ensure that the traits summarized by Williams are alive and well in NWAC operations and in the currently revised production and dissemination of the daily suite of products and services (see the newly designed web site and its more graphical interface to see these traits displayed firsthand). To achieve this end of maintaining the most efficient and useful program possible, the following annual budget figures have been developed. However, for both the present and the anticipated budgets summarized below [Federal fiscal years include October-December of the previous year and January-September of the indicated year—e.g., FY 10 runs from October of 2009 through September of 2010], please note that these projections were developed with the additional following assumptions:

- A small amount of carryover funds are anticipated from FY10 to FY11
- Flat support levels are expected to continue from the Forest Service in terms of appropriated monies from the Mt Baker Snoqualmie National Forest
- Flat annual cooperator contributions are anticipated from the National Park Service, WSPRC and WSDOT
- In FY07, NWAC received $31,562 from Title II/RAC programs (North MBS, South MBS and Kittitas) and $19,516 in FY08 (North MBS, South MBS). However, due to

the fact that the Title II/RAC program was reenacted very late by the federal government for FY09, most counties chose to carry such funding into FY10. Hence NWAC received no RAC monies for operations during the FY09 fiscal year and no RAC grant monies are projected for the current fiscal year, FY10. Such a decline in previously important program contributions is playing a significant part in NWAC's declining revenues. Although no RAC monies are projected for FY10, NWAC continues to submit proposals and presentations for a variety of grant funding and it is hoped that at least some will be successful.

- Unemployment and Medical expenses of approximately $14,000 in FY08 and prior years have dropped to less than $1,000 for both FY09, FY10 and FY11 due to year-round funding through fire or fire research related programs for two of the forecasters and a continued LWOP status during the summer months for the third forecaster.
- Federally mandated salary increases of approximately 2% in January of 2009 with another 2% increase in January of 2010 have resulted in almost 93% (95%) of project costs directed toward salaries in FY10 (FY11). As a result, capital equipment expenditures needed to maintain the mountain weather instrumentation network have reached critically low figures.
- While FOAC's direct contribution toward NWAC operation is expected to remain at $5,000, it remains committed to the funding necessary to finish Phase II of the new web site this summer and fall. Web site development expenses to date have been over $30,000 with another $25,000+ required to implement the planned enhancements and interactive forecast and data retrieval modules expected in Phase II. Despite these expenses, it is encouraging to note that advertising on the new FOAC web site brought in FOAC revenues of almost $25,000 for this past year.
- 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; with current projected funding levels, these services should encompass the whole normal forecast season but may not extend into the spring. This "all or nothing" operational program response to funding levels has been previously agreed upon with cooperators as the best way to meet future monetary shortages.
- Capital equipment expenditures for both FY10 and FY11 are anticipated around $5,000 annually. However, with a projected average life span of 8-10 year/sensor and capital equipment investment in the field currently reaching upwards of ~$300-400,000, a conservative 10% replacement rate means that $30-40,000/year should be dedicated to the data network in order to keep it operating effectively and reliably. Unless this shortfall is alleviated, the lack of capital equipment dollars is already being felt and will result in a less reliable instrumentation network in the future

<u>As always it should be noted that the NWAC continues to exist not only because of the direct funding by its many strong cooperators, but also through the many indirect and very important in-kind contributions that help to more completely reflect the overall value of the program</u>. As shown below (Table 4), these indirect monies total well over $200,000 annually, and result in a program that provides substantially more benefits (almost $600,000 annually) to each cooperator than its individual contributions might otherwise suggest. Although significant carryover from FY09 has allowed NWAC to continue relatively normal operation in FY10 (excepting the aforementioned drop in capital equipment), the same cannot be said for next year when anticipated revenue decreases of nearly $30,000 are expected. Unfortunately, the projected budget for next fiscal year (FY2011) shown below does not and can not include some

unknown monies that may become available this summer or fall through continued NWAC and FOAC funding efforts, such as Title II/RAC grants, web site advertising and others. And who knows, maybe unexpectedly strong financial support or great monetary ideas at the Annual NWAC Cooperator Meeting in early June will tip the tide toward more stable long term funding. In any case, we gratefully acknowledge the critical roles played by all of our cooperators and supporters who have helped make the NWAC what it has become: one of the most respected, comprehensive and reliable regional avalanche and mountain weather forecast centers in the world.

Table 7. Sources of Funding for FY10 and FY11; Total direct and indirect funding.

NWAC Budget—Sources of Funding

Funding Source	[Direct Support]	FY10 [projected]	FY11 [projected]
Federal		**$122,000**	**$127,000**
	USDA-Forest Service	$75,000	$75,000
	National Park Service	$17,000	$17,000
	USDA-FS Fee Demo	$30,000	$35,000
Washington State		**$133,000**	**$133,000**
	Parks and Recreation Commission (includes State General Fund $)	$79,000	$79,000
	Department of Transportation	$45,000	$45,000
	WA Supplemental Budget	$0	$0
	Snowpark Program	$4,500	$4,500
	Snowmobile Program	$4,500	$6,000
County		**$0**	**$0**
	Title II/Resource Advisory Comm.	$0	$0
Private + Carryover		**$77,143**	**$46,702**
	PNSAA & Ski Washington	$25,000	$25,000
	FOAC	$5,000	$5,000
	Other private	$425	$10,000
	Carryover from FY09/FY10	$46,718	$6,702
TOTAL	**[Direct Support]**	**$332,143**	**$306,702**
Estimated In-Kind Support (+2% FY10, 2% FY10)		**$243,406**	**$263,815**
[Indirect support]	USDA-FS (~30% of direct support)	$30,000	$30,000
	WSDOT (obs + equip. support)	$23,883	$24,361
	NPS (obs + equip. support)	$5,725	$5,840
	NWS (office costs + product access etc)	$69,467	$70,856
	PNSAA (obs, power, phone etc)	$7,925	$8,084
	All (one time cost for data support)	$63,406	$64,674
	FOAC (web site development, equip)	$36,000	$25,000
GRAND TOTAL	**[DIRECT + INDIRECT]**	**$568,549**	**$570,517**

Figure 19. NWAC—Projected FY10 Expenses

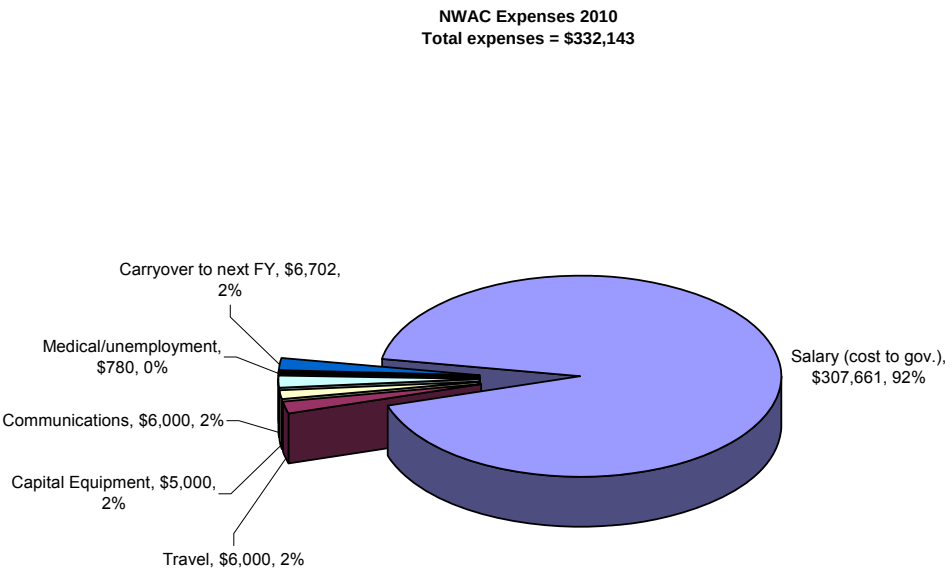
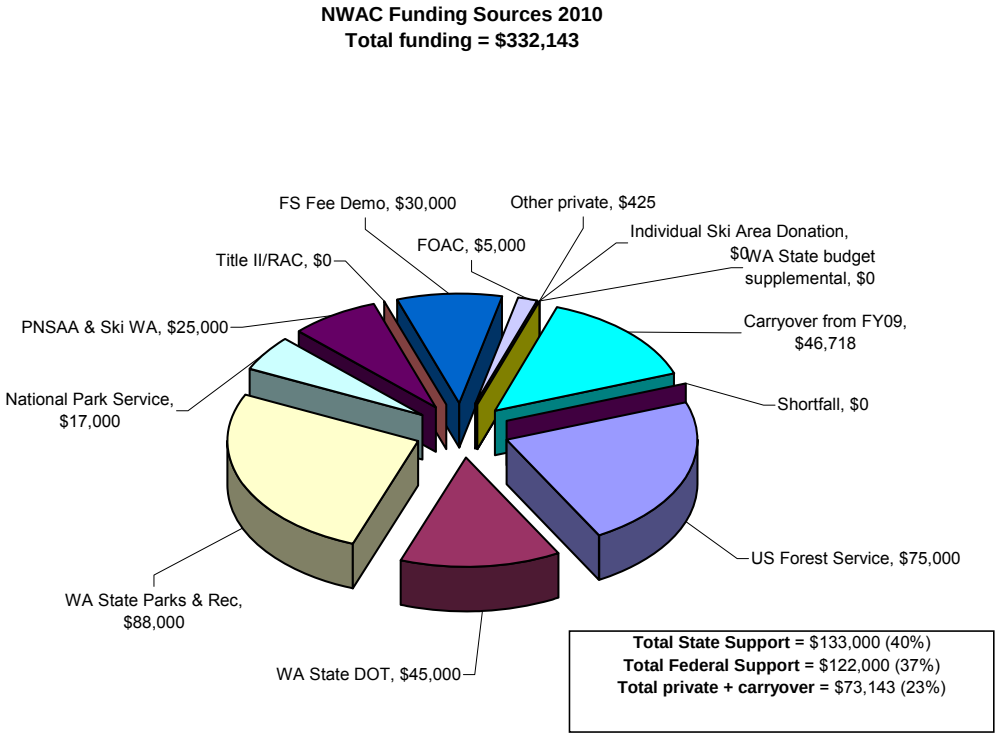


Figure 20. NWAC—Projected FY10 Income



NWAC STAFF

Biographies and photos of both current and past forecasters at the NWAC are available on the staff page of the NWAC web site. However, short summaries of current forecast staff (three full time avalanche-meteorologists) during the past winter are also given below.

- **Mark Moore** – Director and forecaster at the NWAC since its inception in 1976. Focal point for budgeting, avalanche accident information, web site evolution and development, computer and weather station management, avalanche poet. Experienced weather station guru and fire weather researcher in the summer (www.airfire.org).

- **Kenny Kramer** – Forecaster at the NWAC since 1990. Focal point for AWIPS (Automatic Weather Information Processing system) maps and macros, Resource Advisory Committee (RAC/Title II) proposals. Northwest Region 6 FS-RAWS instrumentation coordinator in the summer between bike rides and golf.

- **Garth Ferber** – Forecaster at the NWAC since 1993. Local BC legend, focal point for weather station programs and data, forecast products, FOAC Snow Pack Information Exchange. Summer biker, hiker, climber and general adventurer.

THE LAST WORD

Egad late May, strong spring storm—
Is this really the new norm?
Naw, just El Niño winding down—
Shredders smiling, hikers frown.

But wait' til sun hits that snow—
When gravity dictates where to go..
Cornice falls, wet loose slides—
Can provide some dangerous rides.

Even when winter's mostly done—
Stay aware as you have your fun.
Melting snow as it moves downhill—
Can still provide quite a thrill.

- Mark Moore (late spring lament)

LIST OF ACRONYMS USED

AWIPS—Advanced Weather Information Processing System
FOAC—Friends of the Avalanche Center
ISSW—International Snow Science Workshop
NCDC—National Climatic Data Center
NCEP—National Center for Environmental Prediction
NPS—National Park Service
NSAS—Northwest Snow and Avalanche Summit
NWAC—Northwest Weather and Avalanche Center
NWS—National Weather Service
PNSAA—Pacific Northwest Ski Area Association
RAC/Title II—Resource Advisory Committee (Federal Grant Program)
USFS, USDA-FS—United States (Department of Agriculture) Forest Service
WSDOT—Washington State Department of Transportation
WSPRC—Washington State Parks and Recreation Commission