

Northwest Weather & Avalanche Center



2010-2011 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, Washington State Department of Transportation, Northwest Winter Sports Foundation, Pacific Northwest Ski Area Association, Ski Washington, 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:

After a month of low snow levels that hovered mostly between 2 and 4000 feet and 100-120 inches of snowfall, the April Fool's rain event and associated warming that began on March 30th and extended into April 1st produced freezing levels reaching 6-8000 feet in the central WA Cascades and 2-day rainfall totals ranging up to 5 to 7 inches near Stevens and Snoqualmie Passes. A very significant avalanche cycle resulted in the Pacific Northwest, including 6-10 foot slabs releasing from control within the Crystal Mt ski area, 10-20 ft. natural slabs on the higher elevation east slopes of Mt Hood, and these large wet slabs that originated in the Old Faithful slide paths and blocked the US-2 highway corridor at Stevens Pass. The slides included both controlled and natural releases which damaged a blower and closed the highway for much of the day. In response to the anticipated warming and increasingly heavy precipitation, the NWAC had issued avalanche watches and warnings that began on the 28th of March and culminated on the 30th and 31st when extreme danger was forecast above about 4000 feet. The associated danger roses shown in the lower left corner of the photo indicate the anticipated dangers for the time frame of the slide occurrences. NWAC staff worked long and hard with the Friends of the Northwest Weather and Avalanche Center (FOAC) board and Web Collective of Seattle to design and implement these graphical depictions of avalanche danger by elevation and aspect for any of up to 13 different regions. In addition to introducing the danger roses indicating the highest danger level in the area for the day popping up with a mouse-over of any region, other web site enhancements during the past year included a mobile version of the web site, hourly data graphs, visual highlighting of regions having similar avalanche forecasts on the main map mouse-over, along with a daily danger trend arrow. Photo by Mike Stanford.

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A MESSAGE FROM THE DIRECTOR

Wow, what a remarkable yet sobering year. At times it was saddening and frustrating with four avalanche related fatalities recorded in Washington. At other times it was exciting, challenging, rewarding and tiring, as the winter varied from developing La Niña to La Nada to strong Niña and beyond. Some maximum seasonal snow depths of our robust snowpack overall were not set until late April, regular daily forecasting did not end until April 24th, and special statements and warnings continued well into May. While it was full of technological advances for the Avalanche Center in information communication (enhanced web site with new danger rose, data graphs and 10-day data recall), enjoyment of these improvements was tempered by the real potential for losing both federal and state funding of the NWAC due to budgetary crises. Although there has been some limited recovery (see the Budget section), the resolution of this dilemma at the state level is still under legislative discussion as of this writing. But at least state general fund support of NWAC has been restored in both House and Senate versions of the biennial Washington State budget bill—a bill that may meet with approval by month's end. However, with continued federal funding from the administering agency (Forest Service) contingent on a stable and long term funding base from all cooperators, future NWAC viability remains an uncertain proposition.

In any case, after a long summer of fire weather work interspersed with a lot of forecaster, developer and FOAC effort on the whats and hows of our new danger rose application and other web site developments, the early fall of 2010 provided a good re-introduction to wintertime issues through staff attendance of a most interesting International Snow Science Workshop 2010 at Squaw Valley, CA. After this meeting stimulated our senses and synapses with a host of snow and avalanche discussions, NWAC staff plunged further into the operational integration of danger roses with the avalanche forecasts...at least whenever our normal fall instrumentation and weather station maintenance schedule allowed. After installing a new and relocated base weather station at Washington Pass—accessed via DOT radio link from several ridge repeaters—this station proved to be a most reliable and useful site, operating mostly flawlessly for the entire winter. Other early season instrumentation work focused on repairs of sensors, lines, & data loggers at White Pass, Crystal Mt, Snoqualmie Pass, Stevens Pass (Grace Lakes) Timberline Lodge and Mt Hood Meadows.

After intermittent snows in late October and early November increased in mid-late November, NWAC began the daily forecasting season somewhat hesitantly in late November, fearing for what could be an unusual winter season associated with a highly advertised and potentially robust La Niña driven winter. However, seasonal forecasting being what it is—highly variable and always debatable—the early winter thru mid-January did not seem to be too much out of the ordinary, with reasonable to a bit above average snowfall coupled with several rather normal heavy rain events. But then everything changed...first shifting toward drier and warmer and then finally to a sustained westerly flow that finally corroborated the long range forecasts that NWAC and NWS forecasters had been championing since the fall. In short—cool and wet...and boy was this on the money!

In late January into about mid-February, a split flow alternating with a building upper ridge offshore diverted or weakened most incoming storm energy for much of the period and had many folks grumbling about the long range forecasts of a “great and snowy winter”. But even during this time, the corresponding preferred jetstream patterns—upper ridge over the Gulf of Alaska or an increased and variable westerly flow into the region—did mimic those flows most commonly associated with El Niño’s female sibling. After an unusually wet Martin Luther King holiday, wet even by PNW standards, the remainder of the winter—which extended well into May—set a variety of records for being one of the coolest and snowiest in many years. The prolonged moderate to strong westerly flow that impacted the region for most of the March-April time period seemed to vary only by the date, with forecasters hard pressed to find the end and beginning of the 500-mb weather chart loop. Consider the following interesting factoids for the 2010-11 winter season (October to May):

- *The average freezing level—3,490 ft—for Quillayute (Forks—north-central WA coast), WA for April, 2011 was the lowest of ANY month since March of 2009 (2,150 ft). In fact, the average Forks, WA freezing levels (twice/day radiosonde launches) for the 2010/11 winter peaked in January at 5,310 ft, and then began a significant cooling decline through April*
- *The WSDOT recording station at the Schmidt Haus, Stevens Pass, WA recorded the most April snowfall (86 inches) since record keeping began at this location over 60 years ago*
 - *April was also the 2nd snowiest month (84 inches) of any April ever for Snoqualmie Pass (3000 ft). The snowiest April ever at Snoqualmie Pass occurred in 1955 and totaled 97 inches—which was preceded by a 221 inch March total.*
- *Several NWAC weather stations received their maximum monthly snowfall for the season in April (not even a winter month)*
- *The abnormally large and prolonged duration of winter into spring also delayed the normal re-opening of both the Chinook-Cayuse and the Washington Pass corridors by several weeks or more...with Cayuse not opening until May 26th and Washington Pass on May 25th.*
- *While normally a very difficult development due to higher sun angles, longer days and resulting strengthening radiation effects, many NWAC mountain weather stations still achieved their seasonal maximum snow depth in late April (the 29th), with some retesting but not quite achieving these lofty levels again in early May.*

With a prolonged period of cooler than normal weather following the warm and robust MLK crust, significant faceting and snowpack weakening occurring near this crust region became a major concern as increasingly heavy loading was applied to this layer in later February into April. While no single storm produced deep slab instability, several produced some isolated but very large slide releases down to this old facet/crust combo (e.g., Mt Hood Meadows, Crystal Mt, Mt Baker) along with abundant human triggered releases that produced a fatality and several accidents. However, intermittent surface hoar development also played an active role in frequent avalanche activity from

the later winter into early spring time frame, along with just lots of snow, and intermittent strong winds that loaded weaker storm snow layers.

Now that we have had some time to reflect upon the season past we are sobered by the number of accidents that did occur but thankful that our unusual snowpack development (deeply buried persistent weak layers) did not result in more injuries or fatalities. However as of this writing, danger associated with the very slowly settling and stabilizing winter snow is far from over, and we will need to be vigilant and observant over the next month or so...especially if we encounter more springlike (dare I say summerlike?) weather for more than a day...as the potential for a large spring slide cycle still looms large. But with public safety as our mission, and sufficient funding to monitor and inform recreationalists and cooperators regarding the unfolding snowpack May into early June, we hope to minimize any more avalanche involvements.

Looking further into the future, we are excited about several technological and educational advances and cooperative projects that appear likely before next winter season...all of which should help communicate avalanche information more effectively and efficiently. Such developments may include automatic GIS mapping of danger levels and avalanche occurrence data, enhanced mobile phone apps that allow for relatively instant avalanche related information exchange among users, cooperators and forecasters, and a new search function for NWAC web site information. Stay tuned...and thanks to all for your most important support and usage of NWAC products and services.

—Mark Moore, Director— May 15, 2011

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 and services.
- * Prepare cooperator agreements and administer budgetary and funding 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 (special conditions) 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 allow.
- * 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 avalanche crews at Washington and Cayuse/Chinook passes during their time of spring reopening.

- * 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 budget and overall 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 most major NW ski areas, WSDOT avalanche crews, and NPS observers at Hurricane Ridge in the Olympics 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 (Olympics) 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, which displays forecast model output, radar, satellite imagery, radiosonde information and surface observations.

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 22 years is available upon request. Such information may be available automatically via the web site during future forecast seasons.

2010-11 WINTER WEATHER AND AVALANCHE SUMMARY

A Good Start Mid November to mid January: Several periods of heavy snow and a couple of Pineapple Expresses were seen during the initial period of the winter. We started our forecasting season on 24 November - the day before Thanksgiving Day. It was to be a long season of early mornings that did not end until late April.....

The first avalanche fatality of the season occurred on 4 December when a solo climber was killed by an avalanche in a steep confined gully on [Morning Star Peak](#) at 3100 feet in the central Cascades. This accident occurred during a dry period that lasted from about 3-7 December. The NWAC does not have a nearby weather station but the Quillayute soundings indicate a warming trend during that period.

Date	Freezing Level
0400 PST 3 Dec 2010	3000 feet
0400 PST 4 Dec 2010	5200 feet
0400 PST 5 Dec 2010	6500 feet
0400 PST 6 Dec 2010	7400 feet
0400 PST 7 Dec 2010	7700 feet

The avalanche danger forecast issued by the NWAC on 4 December indicated a slightly increasing moderate danger for the area. However, even with a relatively shallow snow pack, an overall moderate danger with the steep rocky terrain traps was fatal.



Figure 1. Looking upslope at the Morning Star Peak accident site. Photograph taken on 6 December 2010 by Oyvind Henningsen.

Mother Nature seemed to think that the Northwest needed a periodic Pineapple Express this winter. The first came on 12 and 13 December with most sites near and west of the Cascade crest getting 4-8 inches of precipitation following a period of fairly heavy snow.

Precipitation / Snowfall (inches) for 8 – 13 December 2010:

Date	Mt Baker	Stevens Pass	Snoqualmie Pass	Paradise	White Pass	Timberline
8 Dec	1.38 / 7	.19 / 3	1.02 / 6	.47 / 4	.09 / 1	0 / T
9 Dec	2.28 / 12	.70 / 5	.75 / 5	.75 / 9	.54 / 2	1.02 / 8
10 Dec	1.76 / 14	1.81 / 13	1.79 / 8	.94 / 11	1.68 / M	1.58 / 12
11 Dec	.25 / 2	.12 / 2	.26 / 1	.16 / 1	.24 / M	1.11 / 9
12 Dec	1.64 / 4	2.88 / 10	3.23 / 6	2.41 / 1	1.36 / M	3.05 / 0
13 Dec	3.33 / 6	3.13 / 0	2.78 / 0	1.51 / 0	1.38 / 0	2.18 / 0

NWAC issued the first series of avalanche warnings of the season at this time. Coastal freezing levels rose to 9600-11400 feet. Many natural and human triggered avalanches were reported from both sides of the Cascade crest.

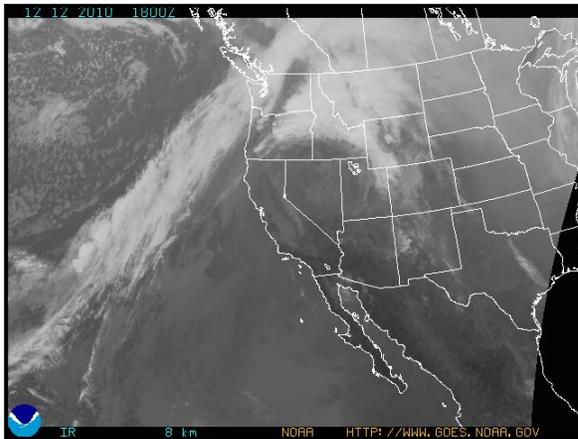


Figure 2. GOES West infrared satellite image from 1000 PST 12 December 2010 showing origin of moisture from southern latitudes.

A period of heavy snow came from about Christmas to 30 December with 2 to 6 feet of snow. This caused us to issue the second series of avalanche warnings for the season with many reports of natural and triggered avalanches at the ski areas and from DOT crews but no serious accidents. An avalanche with a 10 foot

crown was triggered with explosives at Mission Ridge on 26 December. A patroller was caught but not injured on 28 December at Mt Hood Meadows. Another avalanche that day was described at Mt Hood Meadows as “flowing like a freight train” and producing tree damage. During a break in the weather toward the end of the year, NWAC received this picture of an older slab avalanche that was partially covered by more recent snow adjacent to new ski tracks. Sometimes a day or two makes all the difference.



Figure 3. At Hurricane Ridge. Photograph taken 31 December 2010 by Greg Halberg.

A couple more days of heavy snow in the Washington Cascades at the start of a warming trend was seen on 12 and 13 January. Snowfall of 15-26 inches was seen near and west of the crest. This started the third series of avalanche warnings that lasted to mid-January. Ski areas reported a “sketchy, spooky and scary” snowpack and DOT crews at

Stevens and Snoqualmie had large controlled avalanches across the highways. A patroller was caught and carried but not injured on 13 January at Crystal Mountain ski area.

This warming and warning period culminated in the second Pineapple Express of the season seen on 15 and 16 January. Most sites near and west of the crest received 4-8.5 inches of precipitation mostly as rain... Timberline was the winner (loser?) with over 10 inches of water.

Precipitation / Snowfall (inches) for 13 – 17 January 2011:

Date	Mt Baker	Stevens Pass	Snoqualmie Pass	Paradise	White Pass	Timberline
13 Jan	1.40 / 10	1.56 / 10	2.78 / 6	2.27 / 19	1.77 / 2	1.78 / 2
14 Jan	1.46 / 1	1.77 / 0	2.23 / 0	1.26 / 0	.45 / M	1.57 / 0
15 Jan	1.64 / 2	1.44 / 0	1.47 / 0	.87 / 0	.60 / 0	.47 / 0
16 Jan	1.36 / 0	1.94 / 0	2.59 / 0	3.16 / 0	1.75 / 0	3.44 / 0
17 Jan	2.72 / 0	4.88 / 0	3.82 / 0	3.08 / 1	4.11 / 0	6.76 / 0

Precipitation intensities averaged over .5 inches per hour at Timberline for about a 12 hour period from 4 am to 4 pm on 16 January. Coastal freezing levels rose to 9000-10,400 feet with many natural and human triggered avalanches again reported. This also resulted in a crust that became a bench mark for the winter – the MLK (Martin Luther King) crust.

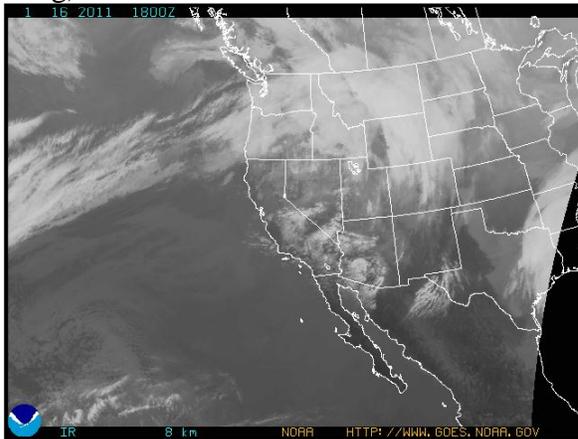


Figure 4. GOES West infrared satellite image from 1000 PST 16 January 2011 at the time Timberline was receiving the heaviest precipitation.



Figure 5. Climax avalanche at Hurricane Ridge. Photograph taken on 18 January 2011 a couple days after the heavy rain event. Photo by Greg Halberg.

A Drought Mid January to Mid February: We generally had a drought during this period that made many of us doubt whether the hoped for La Niña effects would ever materialize. The drought shows up in height of snow charts (see Wrap Up section below) especially at Crystal Mountain.

The second fatality of the season occurred on 1 February. Well-known and loved local skier Monika Johnson walked onto a cornice on top of [Red Mountain](#) at Snoqualmie Pass. The cornice failed and Monika was killed in the resulting loose snow avalanche. The NWAC avalanche danger forecast was moderate for the aspect and elevation of the accident at that time, but cornices are always unpredictable especially when coupled with warming near the time of the incident.

Here is a table of weather data from the NWAC Alpentel weather stations and patrol leading up to the time of the accident:

Date	5400' low and high temp. (°F)	3120' precip. (inches)	3120' new snow (inches)	Alpental ski patrol comments from accident report
25 Jan	30, 40	1.79	0	rain
26 Jan	35, 43	.02	0	
27 Jan	40, 47	0	0	
28 Jan	cooling all day	0	0	
29 Jan	29, 31	1.05	0	7" new snow summit, moderate WSW winds
30 Jan	26, 31	.63	0	8" new snow summit, moderate WSW winds
31 Jan	15, 27	.05	1	cool, clearing
1 Feb	7, 20	0	0	cold, clear

We won't try to draw significant conclusions from this data. The winds, new snow at the higher elevations, and the warming trend the day of the accident may all have been factors but cornice failures are hard to predict.



Figure 6. Photograph from KOMO TV helicopter the day after the Red Mountain accident showing where the cornice appears to have broken in the lower left and her gear left behind on the summit.

The annual Alpental Randonee Ski Rally (Vertfest—described below in the “FOAC and Other Private Support” section) has been renamed in Monika’s honor.

Periods of fair and colder weather were generally seen early to mid-February. Surface and near surface faceted snow over the MLK crust became a February facet – MLK crust combination that was reported from many areas and was a factor in many avalanches throughout the rest of the winter and well into the spring. An article that follows this potentially deadly PWL (persistent weak layer) combination at Crystal Mountain Ski Area from its inception thru the remainder of the winter was authored by Crystal Mt Pro Patroller Chris Morin and is available on our web site under the Education tab, [“Tracking the Impact of a Facet–Crust Combination at Crystal Mountain, WA”](#).

Some spectacular wind speeds were seen on 12 February at the NWAC Camp Muir weather station at 10,100 feet on Mt Rainier (speeds in mph):

Table 1. Mt Rainier Camp Muir winds on February 12, 2011.

Time	Minimum	Average	Maximum
800	85	100	113
900	90	102	114
1000	91	103	114
1100	97	112	131
1200	96	114	135
1300	95	117	137
1400	105	128	152
1500	107	132	155
1600	83	120	141
1700	96	111	127
1800	97	112	124
1900	87	112	130
2000	59	83	102



Figure 7. Mt Rainier behind Rampart Ridge during the Camp Muir wind event. Photograph by Doug Daniell.

By mid-February many were singing the lack of snow blues and wondering what had become of all the promised La Niña snow. At about this time I overheard a conversation at the local Mari-time watering hole:

Billy Snow Crystal: “You seen any of that La Niña snow yet?”

Jack Palance: “Nope.”

Billy: “Seems like it ain’t gonna happen.”

Jack: “Winter ain’t over yet.”

La Niña Finish Late February through April: Well winter wasn’t over yet because La Niña kicked into high gear in late winter and spring here in the maritime Northwest. The 22 February to 15 March period gave us an extended 4th period of avalanche warnings and avalanche accidents as 10 – 20 feet of snow arrived in most areas near and west of the crest.

Snowfall totals (inches) for 22 February to 15 March 2011 included the following:

Mt Baker	Stevens Pass	Paradise	Timberline	Hood Meadows
220	149	166	118	138

On 29 February an off duty patroller at [Mt Hood Meadows](#) escaped with a close call due to a skilled partner.

On 4 March a snowboarder that was part of a film project was seriously injured on a north slope on [Grouse Ridge](#) near Mt Baker at about 5400 feet. After a heroic evacuation the crew later noted that all 7 factors of ALPTRUTH were present. The ALPTRUTH acronym is the result of a study by Ian McCammon that indicates that 92% of avalanche accidents occur when 3 of 7 factors are present (Avalanches, Loading, Paths, Terrain Trap, Rating, Unstable Snow, and Thawing).

The third fatality of the season was seen on 5 March at [Mt Cashmere](#) which is east of the Cascade crest near Leavenworth. A back country skier triggered the slab on a rollover where recent snow had accumulated on the February facet - MLK crust. The victim was carried into trees where he sustained fatal injuries.



Figure 8. Looking down the Mt Cashmere avalanche path. Photograph taken 7 March 2011 by Mike Miller.

The accident report notes that the average height of snow in that area was 250 cm but the height of snow at the trigger point was only 45 cm.

Large avalanches were explosively triggered at the Mt Baker Ski Area in early March.

Figure 9. Old ski tracks are visible on the bed surface of this explosively triggered avalanche at Mt Baker Ski Area. Photograph taken 6 March 2011 by Gwyn Howat.



With all of the late February and early March snow accumulating on the February facet - MLK crust an enormous R5D5 (largest relative to path, and most destructive) avalanche was explosively triggered on 10 March at Mt Hood Meadows.



Figure 10. Note person in lower right at Mt Hood Meadows. Photo taken 11 March 2011 by Ron Martin.

The fourth fatality of the season occurred on the south or backside of [Cowboy Mountain](#) near Stevens Pass on 27 March. The victim triggered a shallow wet snow avalanche that entrained more wet snow and carried him into trees. The 20 year old snow boarder was uncovered in 2-3 minutes but could not be revived despite over 1.5 hours of CPR.



Figure 11. Avalanche path where it descended into the tree band at Cowboy Mountain accident site. Photo by Patty Morrison.

The third deluge of the season came on 30 March to 1 April with most NWAC sites getting 2-6 inches of rain and with Snoqualmie topping out at 8.5 inches. Coastal freezing levels rose to 9-11,700 feet. This caused the 5th short period of warnings at the end of March.

Precipitation / Snowfall (inches) for 30 March - 1 April 2011:

Date	Mt Baker	Stevens Pass	Snoqualmie Pass	Paradise	White Pass	Timberline
30 Mar	.36 / 6	1.31 / 6	2.39 / 1	1.86 / 5	1.26 / 0	2.45 / 6
31 Mar	1.95 / 13	3.48 / 6	4.17 / 0	2.83 / 3	1.04 / 0	.87 / 0
1 Apr	.63 / 2	1.86 / T	1.93 / 0	1.14 / 2	.68 / 0	.35 / 0

Figure 12. GOES West infrared satellite image for 400 PST 30 March 2011 at the start of the event. Note the large moisture plume originating in more southern latitudes and extending into the NW.

Another huge natural D5 avalanche was reported on 30 March from Mt Hood Meadows, once again releasing on the February facet - MLK crust.

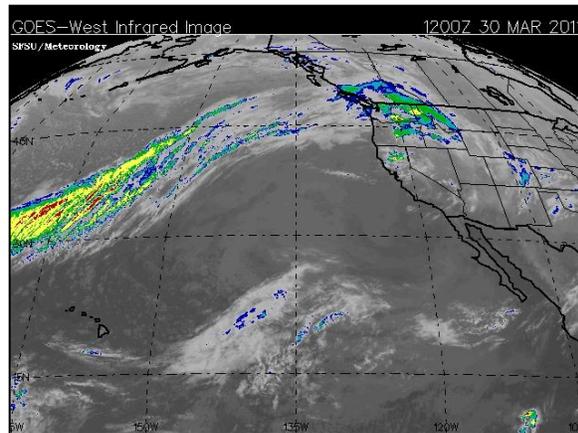




Figure 12. Mt Hood Meadows avalanche debris. Note the 2 skiers one near the center and one in the lower right. Photo taken 1 April by Paul Klein.



Figure 13. Blower caught in an avalanche at Stevens Pass. Mike Stanford photo, 31 March 2011.

Figure 14. Some of the blower damage from an avalanche at Stevens Pass. Mike Stanford photo, 31 March 2011.



Large explosive control avalanches to the February facet – MLK crust were triggered on 2 and 3 April at Crystal Mountain Ski Area in their Niagras, Bear Pit and Employee Housing paths.



Figure 15. Bear Pit crown. Photo taken 2 April 2011 by Chris Morin.

Figure 16. Looking down the Bear Pit path. 2 April 2011 photo by Chris Morin.



The strong La Niña conditions continued with a vengeance in April. NWAC sites near and west of the crest received another 5.5-12.5 feet of snowfall in April.

Snowfall (inches) for April 2011:

Mt Baker	Stevens Pass	Snoqualmie Pass	Crystal Mountain	Paradise	Timberline
130	79	64	71	146	149

The heaviest snowfall and last period of warnings came the first week of April. Injury accidents occurred on 3 April at [Rooster Comb Ridge](#) at Stevens Pass and on 6 April on [Mt Snoqualmie](#) at Snoqualmie Pass.

The typical pattern for April was a sustained series of low pressure systems moving through the Gulf of Alaska causing frontal systems to cross the Northwest. Figure 17 shows a 500 mb chart in mid April—indicative of the prolonged west southwest flow over the Northwest throughout most of the month.

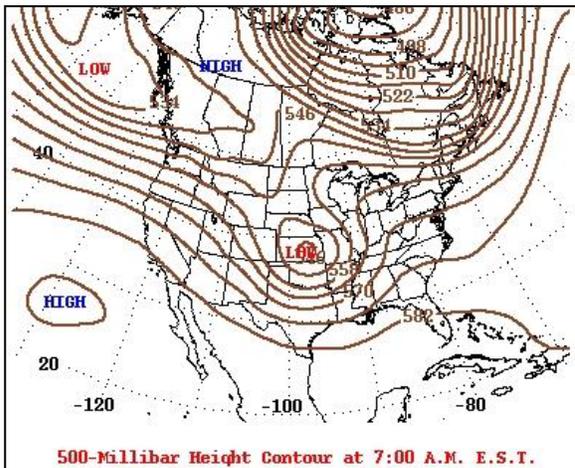
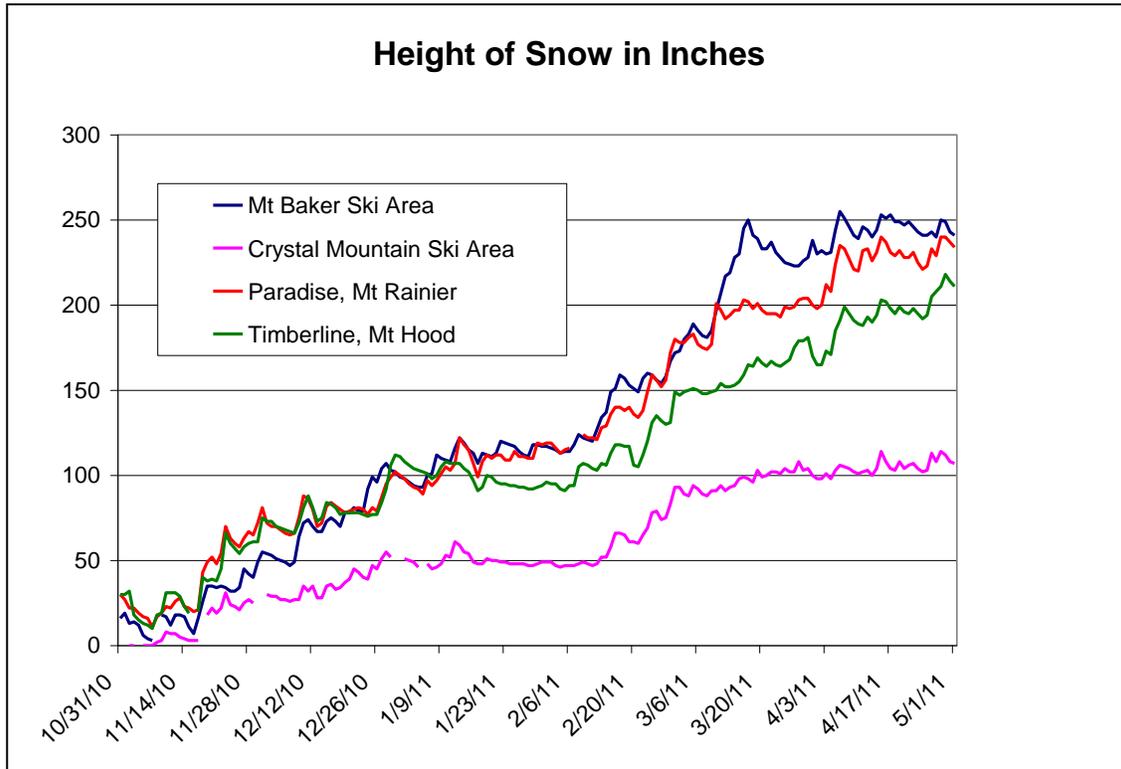


Figure 17. 500 mb height contour map for 400 PST 15 April 2011.

Wrap up: La Niña effects strongly lingered through the spring with snow continuing to pile up into May in the Northwest. Note that seasonal height of snow maximums are normally reached from about 15 March to 1 April:

Figure 18. Height of snow (HS) for selected NW mountain sites for 2010-2011 season.



Another effect of La Niña was seen in lowering monthly average freezing levels at Quillayute, Washington from January to April:

Month	Quillayute (Forks), WA— Average monthly freezing level (feet)
January	5300
February	3800
March	3550
April	3490

Such a cool and snowy period produced some impressive snow depths in April and early May, as indicated in this table of height of snow and percent of normal for some selected NW mountain sites on 1 May:

	Height of Snow (HS)	% of Normal
Hurricane Ridge	170	187
Mt Baker Ski Area	241	175
Stevens Pass	113	140
Snoqualmie Pass	87	147
Crystal Mountain Ski Area	107	149
Paradise, Mt Rainier	244	153
White Pass	66	228
Timberline, Mt Hood	211	138
Mt Hood Meadows Ski Area	156	137

With the effects of the interminably wet and cool winter like conditions extending into May, the Washington DOT crew at Chinook Pass triggered a very large approximately 8-12 foot by 1000 foot wide avalanche to the February facet – MLK crust near the ridge of Knob 1 on 10 May.



Figure 19. Crown on Knob 1 at Chinook Pass. Phtotgraph taken 10 May 2011 by John Stimberis.

Yet another deluge and avalanche cycle was seen on 15 May with an unusual southeast flow over the Cascades causing the heaviest rain along the Cascade east slopes.

Location (NWAC stations except Naches)	2 day precipitation ending morning of 16 May
Washington Pass	1.54
Mazama	1.47
Mission Ridge	2.86
Naches (home weather station— DOT supervisor)	5.04

The GOES West infrared image for 1500 UTC 15 May 2011 shows a large upper low center just west of the northern California coast, with counterclockwise circulation around the low rotating substantial moisture northeastward across WA and northern OR:

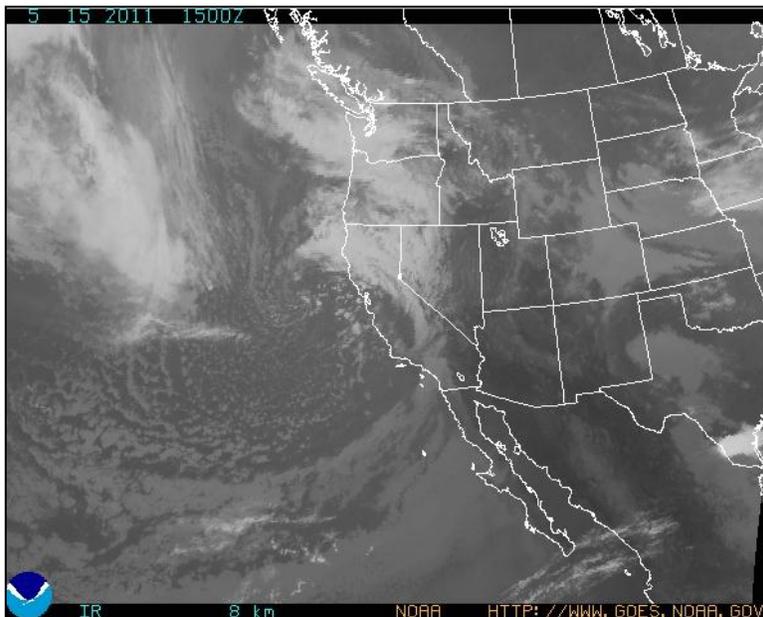


Figure 20. GOES West infrared satellite image from 800 PDT 15 May 2011.

A large GooGoo Cluster crossed the North Cascades Highway about 14 May 2011 below Ruby Mountain, with this mud, snow, tree and rock mix avalanche extending well below the average snow line in the surrounding terrain. This weather also produced other large wet slab slide activity, some to the MLK crust and

some to the ground which was becoming a wet and weak sliding surface.

Figure 21. North Cascades Highway below Ruby Mountain. John Scurlock photo on 14 May 2011.



Figure 22. Captain Point near Stevens Pass. Matthew Burton photo 14 May 2011.



Warnings for the 2010 – 2011 Season:

The number of Avalanche Warnings issued by the NWAC by month was about normal through February but above to well above normal in March and April.

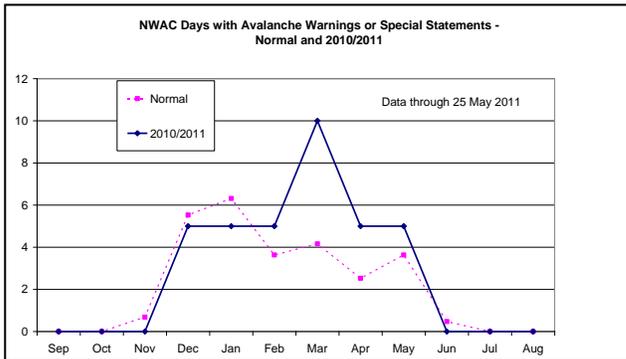
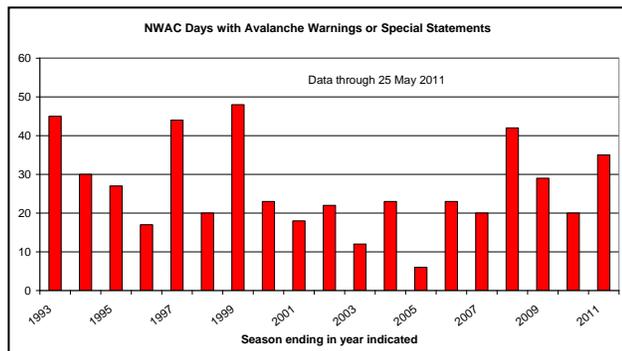


Figure 23. NWAC avalanche warnings by month using records since 1993.

Overall for this season the total number of Warnings issued by the NWAC through mid-late May was somewhat above the average of 26 over the past 18 years.

Figure 24. NWAC avalanche warnings by season since 1993.



AVALANCHE ACCIDENTS AND TRENDS

US And North American Statistics

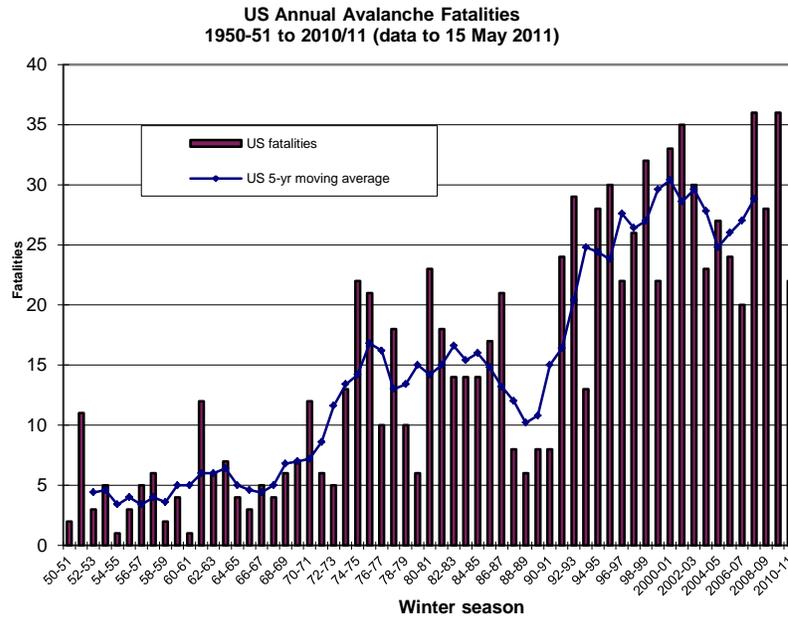


Figure 25. US annual avalanche fatalities by year, 1950-2011.

Through mid-May the US fatality toll was only 22, well below the 5-year moving average of 28. However at this point in mid-May, a large amount of recent snow has yet to settle, stabilize and melt, and statistics suggest there are often secondary increases in

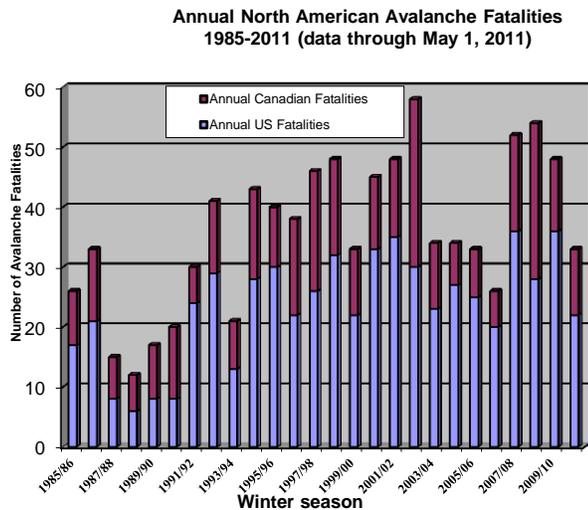


Figure 26. North American Avalanche Fatalities by year, 1985-2011.

La Niña driven snowcover. Overall during the past 10 years, US avalanche fatalities by user group have been led by either snowmobilers or BC skiers, who collectively comprise

As mentioned in the *Message from the Director* the past strong La Niña winter was a challenging one avalanche-wise in many areas of the US, especially across the northern tier of the US where the effects of this ENSO event were most evident. Annual statistics suggest however, that despite many avalanche involvements, a great many folks were given second chances in their

snowpack conflicts with avalanche terrain.

avalanche related fatalities in June, when BC travellers' awareness of the avalanche phenomena seems to wane.

In stark contrast to past winters when avalanche deaths by activity category have been dominated by snowmobilers, back country skiers suffered mightily in 2010/11 and were the primary targets of this

over 66% of all avalanche deaths since 2001/02. During this period, 111 snowmobilers (39% of the total) and 74 BC skiers (27% of the total) have been killed by avalanches. Fortunately, after a bad season for lift skier fatalities (3 in-bounds fatalities) was recorded in 2008/09, this surprising trend was not repeated in subsequent years. However, with one patroller and one lift skier killed in 2009/10 by avalanche and another patroller death in

2010/11 US Avalanche Fatalities by Activity Category
***22 total to May 1, 2011**
 [Data courtesy NWAC, CAIC and WAN]



2010/11, awareness and focus on avalanches continues to be critical for all who spend a significant portion of their work in the snow. Note that the fatalities by activity category figure shown here do not include an additional 11 fatalities in Canada (including 6 snowmobilers in British Columbia, 2 back country skiers in

Figure 27. Annual US avalanche fatalities by activity category

Alberta and 3 back country skiers in BC). See <http://www.avalanche.ca/cac/library/incident-report-database/view> for more detailed Canadian avalanche information.

Northwest Statistics

With a strong La Niña producing some PWL's (persistent weak layers) that developed in late January into early-mid February and persisted in some fashion and produced

Northwest Avalanche Fatalities by Month--1974/75-2010/11
 Total of 93 fatalities over 37 winters
 Data through May 15, 2011

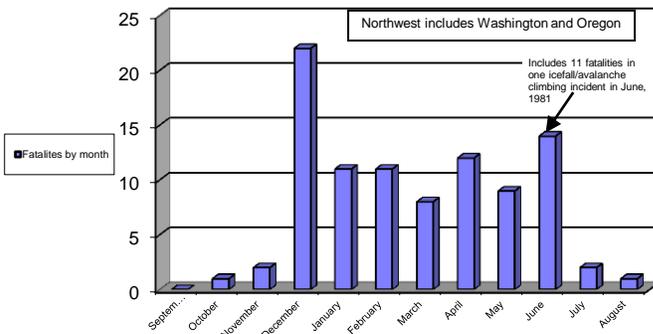


Figure 28. NW avalanche fatalities by month, 1974-2011.

avalanche issues well into May, the resulting unusual NW snowpack surprised experienced travelers and produced many avalanche incidents involving buried weak layers. The four Northwest avalanche fatality total for the 2010/11 winter (at least thru the time of this report printing in mid-late May) was above the 5-year

moving average of 3.6 fatalities/year. As usual,

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

From an analysis of NW avalanche fatalities by month for both the more recent term (past 15 years) and longer term (37 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

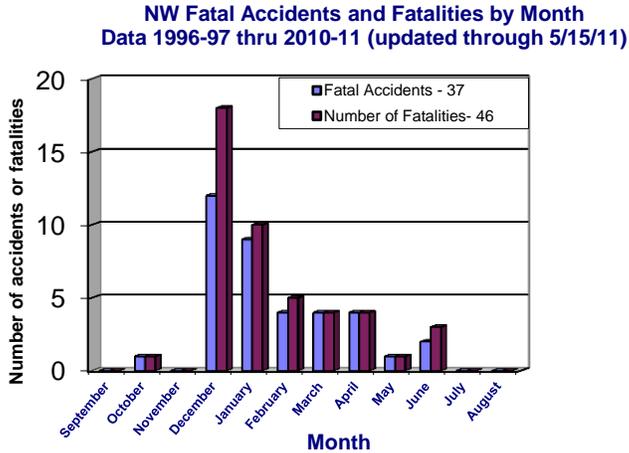


Figure 29. NW avalanche accidents and fatalities by month, 1996-2011.

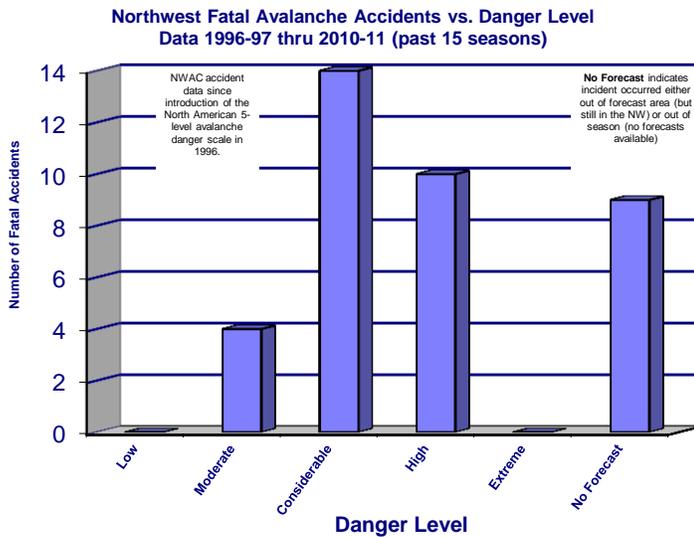


Figure 30. Northwest Fatal Avalanche Accidents by danger level, 1996-2011.

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

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 28 and 29 which span both the more recent 15 years (Fig 29) and the longer term (Fig 28—past 37 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).

As Figure 30 shows, most of the fatal NW incidents occurred when NWAC had forecast either a

(forecasters either in non-pay status or transitioned toward summer time fire-weather work).

Also as is evident from Figure 31, 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. This trend could also be attributable to BC travelers: a) not having the forecast or, b) not being aware that there was a forecast or, c) not caring about the forecast. It is strongly hoped that the new and enhanced NWAC web site presence is helping to improve the distribution of the forecast to a wider audience, and thus at least partially addressing the issues of a) and b) above. Although much more limited options exist for the NWAC to effectively address c) above, more innovative, easier to use, and more timely information exchanges (as are becoming possible via smart phones) may allow for increased opportunities to reach and affect more challenging user (groups).

NW Avalanche Fatalities 1950-2011
(data through May 15, 2011)

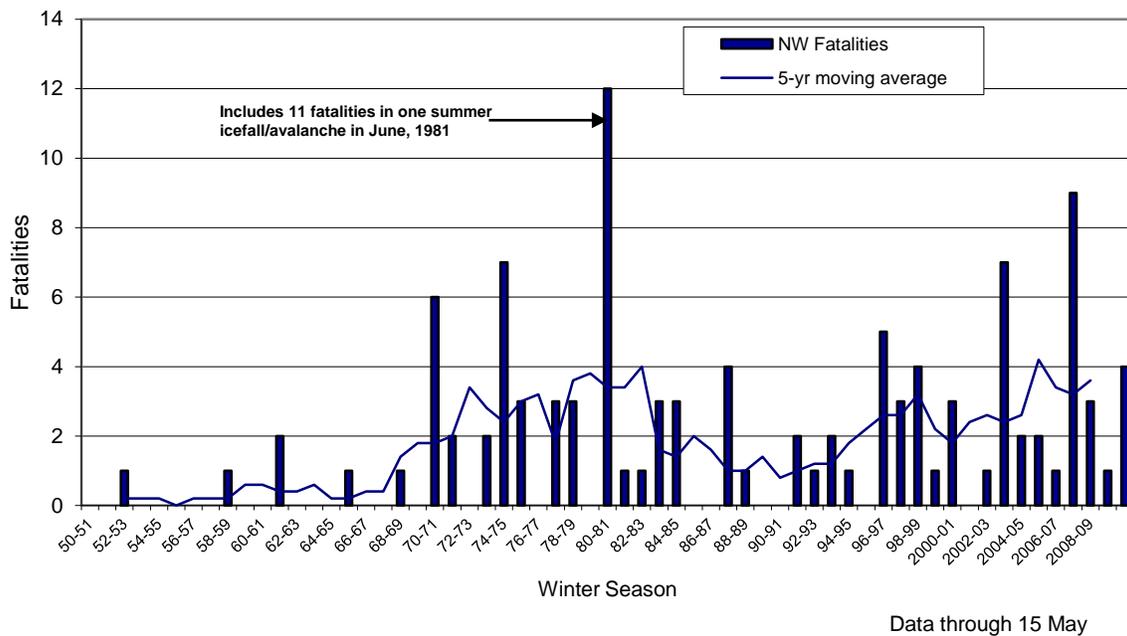


Figure 31. NW Avalanche Fatalities by season, 1950-2011.

During the 26-year time period for the US fatality table by state below (Table 2), a total of 610 (59) 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 2.3/year for Washington and Oregon combined—or about 10% 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 (3.0 and 3.6 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 15, 2011)																													
Winter Season																										26 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	10/11	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	6	149	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	5	3	101	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	2	84	3.2	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	2	79	3.0	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		4	51	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	2	49	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	1	43	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		2	28	1.2	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		1				1	0.0	ND
NM	0	0	0	0	0	0	0	0	0	1	0	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	34	22	610	23.5	TOTAL

Table 2. Annual US Avalanche fatalities by state, 1985-2011.

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 1950-2010. However, it should be noted that this chart does not include indirect heat related deaths in

FATALITIES CAUSED BY NATURAL DISASTER IN WASHINGTON STATE, 1950-2010*

Compiled by Northwest Weather & Avalanche Center

Total number of fatalities by natural disaster = 424

*Avalanche data from 1950 through April, 2011; all other data thru end 2010

Data from WA-DEM, FEMA, DNR, USFS, NWS, U of W

Note: Avalanche fatalities shown do not include an additional 117 deaths recorded from 1910-1949.

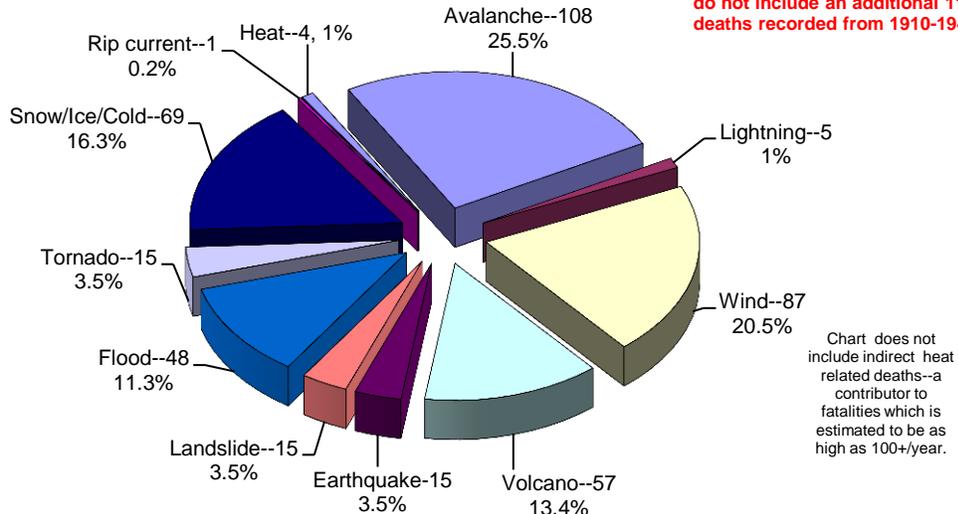


Figure 32. Fatalities caused by natural disaster in Washington State, 1950-2010.

Washington. While an indirect and difficult to measure statistic, it is estimated that approximately 100+ deaths/year (2010 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.

PRODUCT DISSEMINATION AND USAGE

Selected FOAC-NWAC web site traffic statistics: 1995-2009.

From the start of 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 tool. Associated plots 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 spring of 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 (initially presented in the [2009 Report](#)) illustrates this general increase in site use from 1995-2009 and is reproduced for reference below.

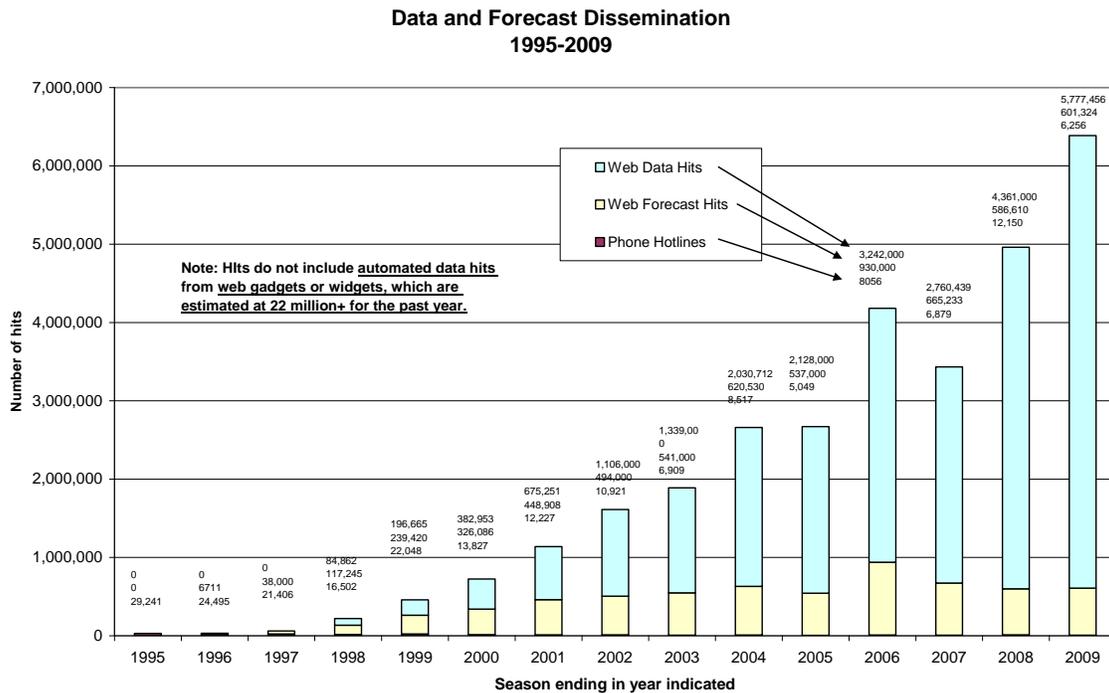


Figure 33. Data and forecast product dissemination by year, 1995-2009.

While raw Wusage access data gathered for the 2008-09 season 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 web site access was

driven in large part by web gadgets, widgets or bots that automatically updated hourly weather information from a variety of NWAC weather stations. Analyses of such site usage 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 the Figure above. However, even if all of the bot or widget driven traffic is filtered out as shown above, forecast product dissemination of around 600,000/year suggest that we have come a very long way 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 from the old Wusage package 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:

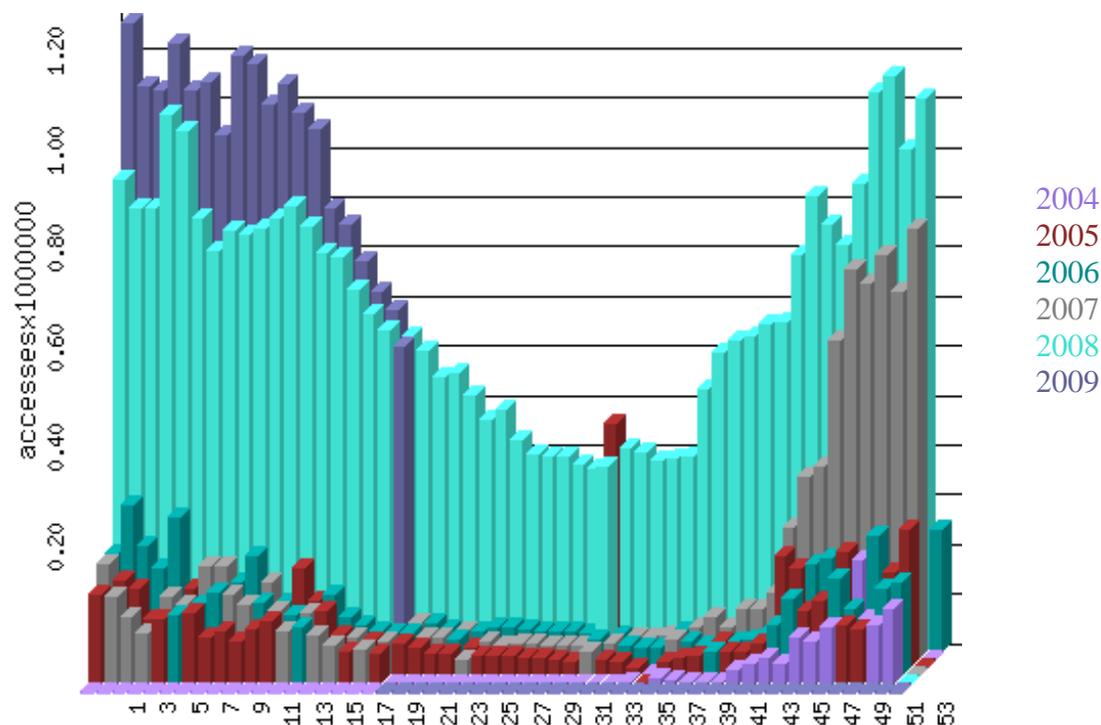


Figure 34. Annual plot of weekly page views (in millions) on NWAC web site, 2004-2009

2009-10

Starting in the 2009-10 winter season, the advent of the new combined FOAC-NWAC web site and its Django programming 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 filter out traffic from robots or worms. As a result, visit comparisons recorded by these products were quite similar. Although the more detailed site traffic analyses provided by Google Analytics tipped the balance in its favor for most traffic analysis, 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 on the web site. Such usage was tracked by AWstats and indicated up to 24 million page views and 50 million hits that are not included here. As a result of the unreasonably high access statistics derived from AWstats inclusion of bot driven accesses, the selected web site statistics given below for both 2009-10 and 2010-11 are primarily derived from Google Analytics, with comparison figures listed from AWstats wherever appropriate.

2010-11

Web site usage comparisons below are from October 1 thru May 15, 2010-11 (and are in bold font) with corresponding 2009-10 figures in parentheses and not bolded:

- **Average visitors/week = ~52,000/week** (42,000/wk)—**ranging from ~27,000 to 108,000/wk**
- **Average unique web site visits/week = ~22,000/wk** (20,000/week)—**ranging from about 15,000 to 35,000/wk**

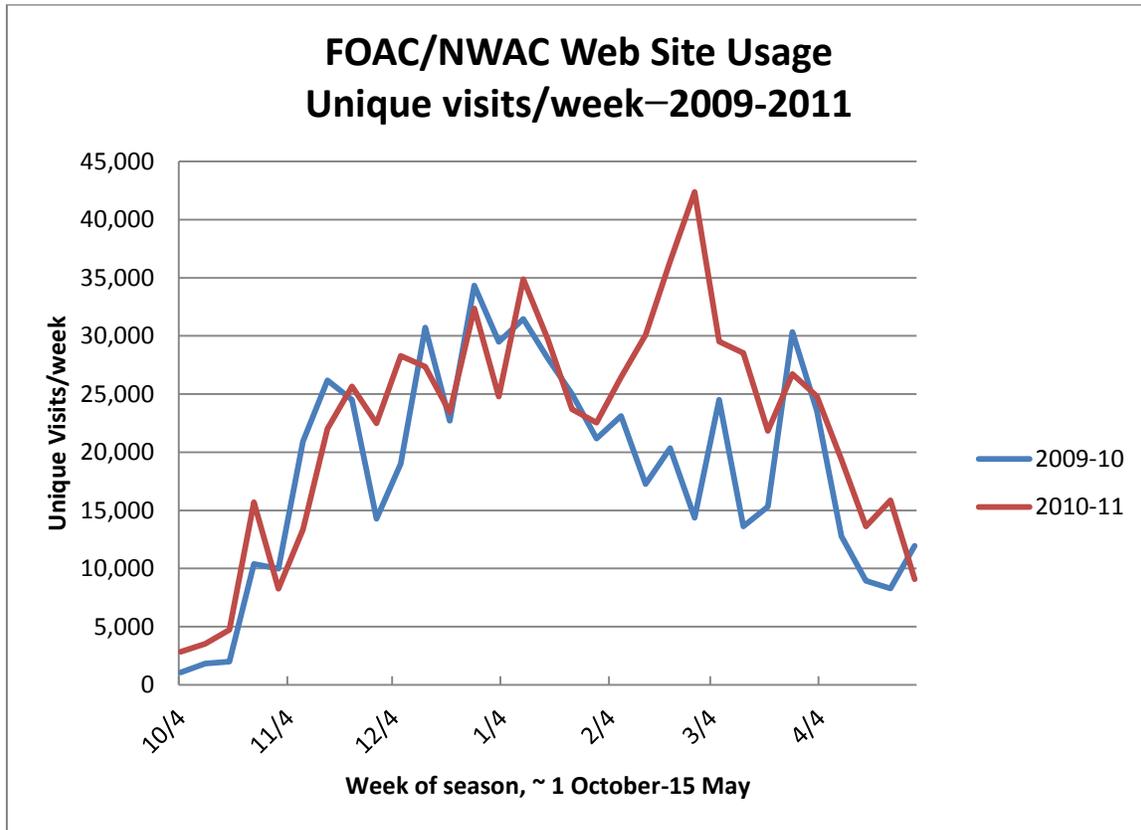


Figure 35. Unique web site visits/week, 2009-2011

Of the approximately 1,658,261 (1,328,000) site visits to nwac.us during 2010-11 (2009-10):

- **~377,949** (320,000) **unique visitors initiated ~3,341,406** (2,870,000) **page views or ~2.02** (2.2) **page views/visit for the 2010-11** (2009-10) **winter season from October 1, 2010** (2009) **thru mid-May, 2011** (2010).

- **This represents an 18% increase in unique visitors during the past year, and a 16% increase in overall visits as compared with 2009-10**

This site traffic was composed of a combination of direct, referring site, and search engine visits as follows [2010-11 (2009-10)]:

- Direct Traffic comprised ~32% of these visits or ~533,683 (432,000) visits
- Referring Sites comprised ~53% of these visits or ~837,575 (701,000) visits. These visits originated from over 1500 separate referring sites. As in 2009-10 the 10 most important referring sites included WSDOT and PNW ski areas.
- Search Engines comprised ~17% (15%) of these visits or ~288,999 (196,000) visits
 - Google comprised ~ 89% (90%) of this total, Bing ~7% (6%) and Yahoo ~2% (3%), with others totaling about 1%

The following figure graphically depicts some of these more recent annual trends listed above in overall web site usage:

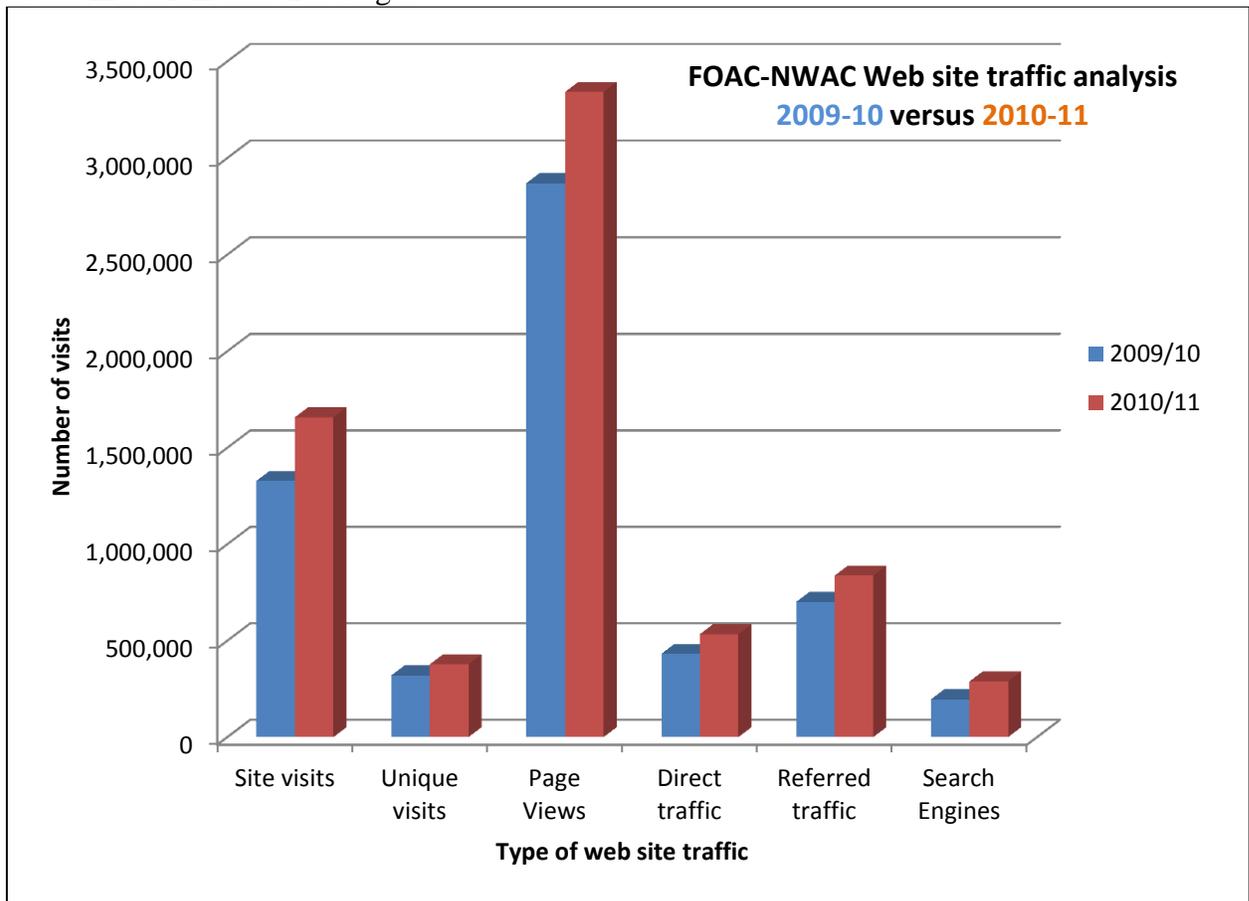


Figure 36. NWAC Web site traffic analysis, 2009-2011

In terms of browser profiles of user accesses, about 38% used Internet Explorer, 30% Safari, 22% Firefox and 8% Chrome.

While the majority of the web site access is from desktop or laptop PC's, mobile phone device access of the web site continues to expand, almost doubling from last year and contributing about 15% of the overall usage or ~242,000 visits in the 2010-11 time period (compared to about 103,000 visits and 8% of the usage in 2009-10). Of the cell devices utilized, iPhone usage totaled about 121,000 visits (~50%), with Android devices totaling 76,000 visits (32%), followed by the iPad at 23,000 visits (9%), the iPod at 11,000 (4.5%), and the BlackBerry at 8,000 visits (3.4%). This increasing usage of mobile phone devices to access forecast products and services is being driven by better and easier to use and view devices as well as gradually expanding cell phone coverage in the mountainous terrain. 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. In a survey of regional US Avalanche Center web site usage taken last year, NWAC product and service access was well above other sites in terms of unique visits and total web page accesses.

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 1500 interested attendees.

DATE	GROUP	LOCATION	ATTENDANCE	SPEAKER
09/18/10	NW Snow and Avalanche Workshop	Redmond, WA	25	Moore, Kramer, Ferber
10/15/10	Pacific Northwest Ski Area Assoc.	Seattle, WA	20	Moore
10/16/10	National Avalanche Center	Squaw Valley, CA	50	Ferber
10/28/10	Mt Baker Film Fest	Bellingham, WA	1500*	Ferber
11/07/10	NW Snow and Avalanche Summit	Seattle, WA	250	Moore
11/07/10	NW Snow and Avalanche Summit	Seattle, WA	250	Ferber
11/13/10	Oregon Mountain Community	Portland, OR	30	Emetaz
11/20/10	White Pass Ski Patrol	White Pass, WA	20	Ferber
12/01/10	REI - Issaquah	Issaquah, WA	40	White
12/07/10	REI -Redmond	Redmond, WA	30	White
12/07/10	Oregon Nordic Club	Portland, OR	50	Emetaz
01/05/11	REI - Alderwood Mall	Lynnwood, WA	33	White
01/07/11	Spokane Parks & Rec.	49 Degrees North	25	Emetaz
1/10-12/2011	Holden Village Staff	Holden Village, WA	75	Emetaz
01/11/11	REI - Issaquah	Issaquah, WA	28	White
01/18/11	Mountaineers	Olympia, WA	40	Emetaz
01/19/11	Mountain Hardware Store	Seattle, WA	4	White
01/20/11	Mountaineers - Climbing class	Everett, WA	32	White
01/20/11	Colville NF & US Fish & Wildlife	Newport, WA	22	Emetaz
01/22/11	Mt St Helens Institute staff	Carson, WA	15	Emetaz
01/23/11	AMS Weather Fest - Annual Conf.	Seattle, WA	500*	Ferber, Redden
01/25/11	REI - Seattle	Seattle, WA	52	White
01/26/11	Mountain Hardware store	Portland, OR	10	Emetaz
01/28/11	Vista School Tour	NWAC	25	Ferber
02/07/11	Boy Scout Troop 284	Seattle, WA	50	Ferber
02/08/11	Mt Hood Ski Bowl -Tele-Tuesday	Government Camp, OR	45	Emetaz
02/13/11	Outdoor Research / FOAC - Vert Fest	Alpental, WA	-	Ferber
02/21/11	Mt Hood Meadows - Patrol	Mt Hood Meadows, OR	7	Moore
02/24/11	WSDOT - Workshop	Leavenworth, WA	40	Ferber
02/28/11	Science On Tap - Lecture Series	Seattle, WA	80	Moore
03/07/11	NWAC / NWS - Tour	NWAC	2	Ferber
03/24/11	Dickenson School - Redmond	Redmond, WA	80	Moore, Redden
04/19/11	Skagit Alpine Club	Mount Vernon, WA	40	Kramer
04/26/11	Everett Mountaineer's	Everett, WA	30	White
	* estimate not included in total	Total	1500	

Table 3. 2010-11Avalanche Education efforts by NWAC & FOAC staff.

As the table below indicates, during the past 15 winter seasons these educational efforts have reached over 26,000 people.

Table 4. NWAC avalanche education efforts by season, 1996-97 thru 2010-11.

Year Start	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Persons	1178	1820	2440	1800	1800	2600	1486	1657	2858	1396	1868	1362	1918	1778	1500
Total for 15 Seasons	26,461														

ISSW 2010



The 16th official ISSW convened October 17th - October 22nd of 2010 at the 'Resort at Squaw Creek' in Squaw Valley, CA.

ISSW returned to Squaw Valley 24 years after its first visit in 1986. The Workshop was held at the Resort at Squaw Creek which comfortably accommodated the largest ISSW to date with over 920 paid registrants – which included 98 registrants from outside of North America.

ISSW continued to cover a broad range of practical and research topics. 60 oral presentations and over 90 posters included among others: investigations of how skiers trigger slabs, analysis of ECT (extended column test) and PST (propagation saw test) tests, avalanche mitigation, strength of snow anchors for rescue, analysis of snow and weather measurements, stability tests, effects

of climate change on snow and avalanches, education and risk management. The field day on Wednesday, which had near perfect fall weather, included a Historic tour of Alpine Meadows and Squaw Valley Avalanche Paths, "A History of the Avalauncher" presentation by Pete Peters, hiking, biking and golf opportunities.

ISSW 2010 also had 128 female registrants which led to another successful Avalanche Divas Social gathering. And over 430 people attended the Thursday night banquet which featured Wes Schimmelpfenning and Andrew McLean as the evening guest speakers.



Figure 37. A merging of theorists and practitioners. ISSW 2010- Squaw Valley, CA. Photo G. Ferber



American Avalanche Association Award

The annual membership meeting of the AAA was held during the ISSW meetings in Squaw Valley. It was at this meeting that NWAC's own Mark Moore received Honorary Membership by the AAA. This is the highest award bestowed by the American Avalanche Association and the list of recipients in the figure below reads as a who's who in the field of snow and avalanches. Mark's dedication and professionalism in this field are recognized throughout the world and the award is a great and fitting tribute to Mark. The award was presented by Mark's long time professional



Figure 38. Rich Marriott brings his wit and recollections to the Honorary Award proceedings. Photo by Kenny Kramer.

associates and close friends, Craig Sterbenz, Rich Marriott and Knox Williams and Patty Morrison.

The screenshot shows the AAA website's 'AWARDS' page. At the top, there's a navigation bar with links for membership, store, education, publications, grants, resources, and about. Below this, the page title 'AWARDS' is prominently displayed. A sidebar on the left contains links for 'American Avalanche Association Memorial List' and 'Petition of Awards Nomination Form'. The main content area features a list of award recipients from 1987 to 2010, including names like Mark B. Moore, Dan Judd and Daniel 'Howie' Howlett, and John Montagne. The page also includes introductory text about the awards program and contact information for the Awards Chair.

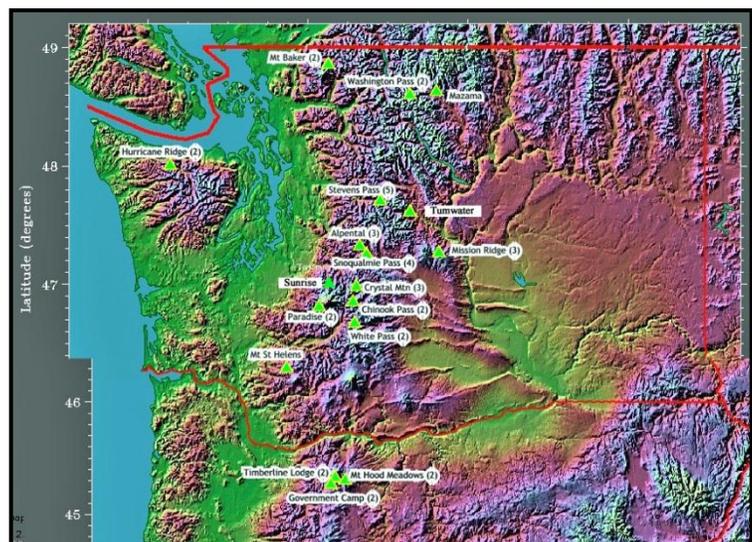
Figure 39. The AAA website lists all of the Honorary Membership Award recipients since 1987.

WEATHER STATION NETWORK

Figure 40. NWAC weather station network.

Summary of NWAC Weather Station Changes 2010-2011 Season

Mt Baker – On 24 September 2010 we upgraded the base weather station datalogger to a Campbell CR1000. This allowed access to real time weather data and instant down loading of weather data via an internet connection. Now both the Pan Dome and Heather Meadows stations are accessed via an internet



connection which has proved to be the fastest and most reliable means of accessing and receiving hourly weather station data.

Washington Pass – On 1 October 2010, with the help of the Washington State DOT avalanche crew, the base weather station at the pass was relocated from the old heavily treed and overgrown site near the over look to a new more open site about ½ mile to the west in a meadow. To summarize, this meant that the old station had to be disassembled, and that a new foundation and new tower had to be erected at the new location. The instruments and communications then had to be installed on the new tower. With one season in the books, we can now report that the new location provided excellent precipitation measurements with the heat to the gage lasting all through the season! The improved radio communications kept data flowing with the greatest regularity we can recall for this remote site.



Figure 41. Erecting the new Washington Pass base weather station on 1 October 2010. Liberty Bell Mountain in the background. Photo by NWAC forecaster Kenny Kramer.

Figure 42. The same scene as the previous photo in April 2011. Photo by Washington State DOT avalanche crew member Brandon Levy.



White Pass – On 6 Oct 2010 at the upper site we installed a new battery, new Battery Tender Jr charger, and rewired all cables on the wind tower. A future project is to upgrade both site towers to the new Rohn 45G standard.

Timberline – replaced the old Campbell CR10 datalogger with a CR10X on 16 November 2010 at the Top of the Mile wind station. Then on 17 November 2011 at the base station we replaced the ailing Judd Total snow gage and added a “hat” to keep the

snow from creeping over the sensor and adversely impacting the gage measurements. Also we replaced the Taylor Wind Direction gage at the top of Pucci since it was not heating.

Mt Hood Meadows – replaced the base station precipitation gage on 16 November 2010 due to gage heating issues. The Judd Total snow gage was also replaced with the help of Tighe Stoyanoff from the Meadows avalanche crew.

Hurricane Ridge – Here is an example of why the measurements from a total snow depth gage could be in error... Hint: Sensor is covered in rime ice!



Figure 43. Rimed total snow gage at Hurricane in December 2010. Photograph by NPS employee Mark Hollingsworth.

Crystal Mountain Ski Area – On 7 January 2011 we replaced the total snow gage at the base site.



Figure 44. NWAC forecaster Kenny Kramer replacing the total snow gage at the Crystal Mountain base site on 7 January 2011. Photo by Garth Ferber.

Stevens Pass – And here is an example at Schmidt Haus of why readings from a 24 hour snow depth gages may be in error... Hint: The gage blew over in strong winds.



Figure 45. Blown over 24 hour snow gage on 17 January 2011 at Schmidt Haus at Stevens Pass. Photo by John Fleckenstein.

Camp Muir – And here is an example of why wind instruments may give bad readings... Hint: riming happens!

Figure 46. Camp Muir wind instruments on 23 January 2011 by Georg Klein. Severe riming extending into the direction of the prevailing SW winds have mostly melted off the wind direction but still mostly envelop the unheated wind speed sensor (right of photo).



Mt Hood Meadows – On 24 January 2011 we added the data from the Cascade Express chair station to the NWAC web site. Unfortunately some critter issues with the telemetry cable rendered much of the data useless last winter. Plans are underway to replace most of the impacted cables by the fall of 2011.

Mt St Helens – On 2 February 2011 we replaced the battery, added a Battery Tender Jr charger, replaced a bad Taylor wind speed instrument, and upgraded the Campbell CR10 datalogger to a CR10X.



Figure 47. NWAC weather station gnome Mark Moore working on Mt St Helens datalogger on 2 February 2011. This datalogger is indoors which is how we like ‘em! Photo by Garth Ferber.



Camp Muir - In May 2011 the National Park Service added a video camera to the station at Camp Muir. The camera is within the inverted glass dome in the upper right of the photo and is pointed south down the Muir snowfield and the Tatoosh Range.

Figure 48. Camp Muir weather instruments in mid May. Photograph by Amar Andalkar.

Figure 49. View in fair weather from the Camp Muir video camera with the Muir snowfield and Tatoosh Range.



Plans for NWAC Weather Stations

Besides the usual regular maintenance and troubleshooting of all the stations some plans for the 2011-2012 season include:

Chinook, Sunrise – we plan to add a radio at the top of the Crystal Mountain Ski Area to access the Chinook and Sunrise weather stations. We hope this link will be more reliable than the current phone lines to Sunrise, which seem to be taken out every year by the November/early December floods. This link will also allow RF access to a future Camp Schurman station, whenever this NPS proposed station comes on line.

Dirty Face Peak – summer plans call for replacement of the batteries at this station (now 5 years old) if we can have them taken to the summit by collaborating on a resupply fire or radio system helicopter flight with the Okanogan-Wenatachee NF.

Taylor Scientific Precipitation Gage - Phil Taylor (the primary engineer who has been repairing NWAC equipment since the early days) is currently finishing a new design 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 purchase and maintain, with some of the heater elements unreliable. We hope to test this new gage as soon as the 2011/2012 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 (FOAC) and other important cooperating groups during the Fall 2010 to Spring 2011 period.

New Website

Over the summer, fall and early winter of 2009, and again over the spring, summer and fall of 2010, the Friends of the NW Weather and Avalanche Center (FOAC) provided necessary funding and direction for an expanding 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 five 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 have now provided the ~\$50,000 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 has brought in some significant revenues to FOAC (about \$20,000/year during its first two seasons of use.

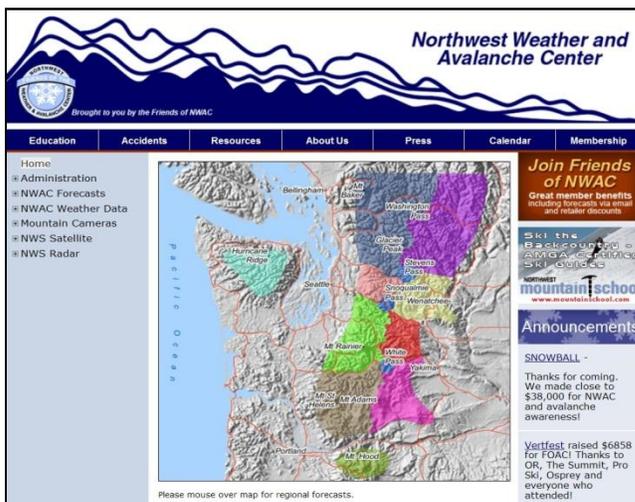


Figure 50. FOAC-NWAC home page; mouseover of a colored region produces a popup of two daily danger roses for the indicated region. Mouse clicks of the region results in detailed forecast display.

Late in the fall of 2009, 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. Unveiled this past winter, Phase 2 of the web site integrated further forecast enhancements to an overall better, more detailed and reliable product through both the 2-day and 3-day time, along with the introduction of a two or three day danger rose and a

much improved mobile device presence and availability.

By now most users and cooperators are probably familiar with the recently evolving face of NWAC products and services. Version 2.2 upgrades planned for the Summer and Fall of 2011 will also be funded by FOAC with Web Collective performing the programming. This work should allow for further site improvements that include:

- Google Site Search function to allow for easier site navigation and easier location of desired data, articles or educational resources
- Better and more robust and reliable templates and editor for forecast entry

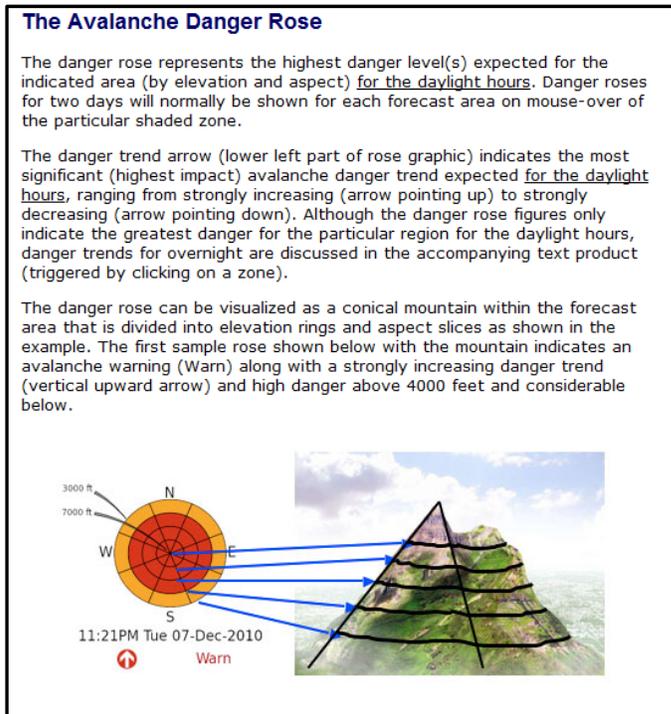


Figure 51. NWAC avalanche danger rose, introduced in the 2010/11 winter.

- Collaboration with software developers to:
 - allow seamless integration with the GIS based danger level and geographical avalanche information display. This may either replace or supplement the popular Snow and Avalanche Information Exchange and allow for more direct user interaction in viewing, depositing and sharing avalanche related information
 - allow hosting of the central regional server software for the iPhone/Droid Instant Avalanche Information App

Overall during the period 2003-2011, the FOAC have dedicated approximately \$210,000 toward NWAC and outreach efforts that support avalanche education and awareness in the PNW region. This total amount involves both direct and indirect support of NWAC, and has included a rather wide range of programs developed to help expand avalanche awareness and education through a variety of venues. Such support includes the following partial list:

- Avalanche Education Efforts and Programs targeted toward youth and the snowmobile community, e.g., Alpine Safety Awareness Program and the Know the Snow Initiative

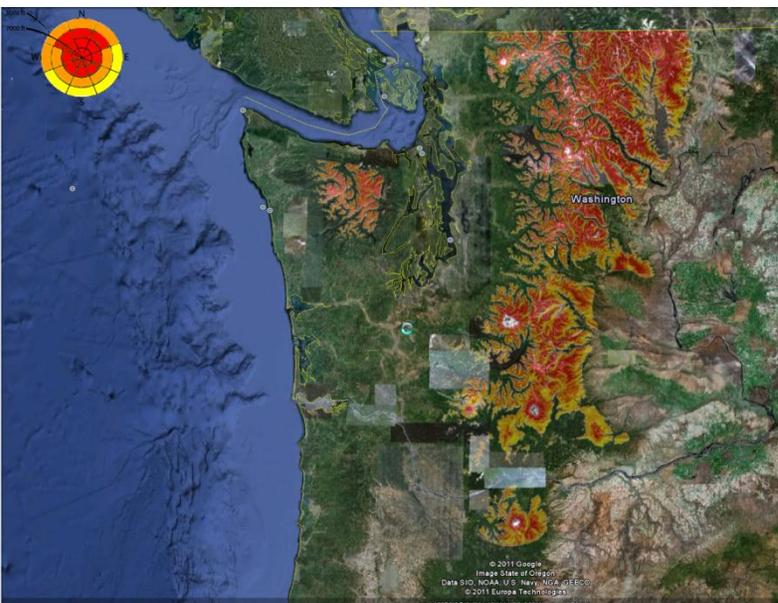
- Development and administration of the collaborative NWAC-FOAC web site, including providing, configuring and paying for the server and the appropriate bandwidth for the web site
- Development, printing and distribution of avalanche awareness signs for Snowparks and trailheads
- Development, printing and dissemination of Avalanche Safety Checklist cards
- Reprinting and distribution of several avalanche awareness and education brochures and hot line business cards
- Collaboration with and funding or partial funding of several avalanche education venues including NSAS and Vertfest
- Donations of several PC's, peripheral equipment and associated software to NWAC
- Avalanche education video production
- Donations of a variety of weather sensors and data loggers for the NWAC data network

Technological Advances in Avalanche Information Sharing

In order to further promote winter safety and critical avalanche information exchange, the NWAC and FOAC are also collaborating with several software programmers and designers to allow for development and introduction of new and innovative ways to view and share avalanche related information (generated by users and cooperators alike). These developments range from unique and compelling GIS applications that allow for more visual and more user friendly methods for input and viewing avalanche danger geographically...to smartphone apps that streamline field entry and subsequent sharing of weather, avalanche and snowpack observations...to better ways of accessing, viewing and interacting with historical forecasts and the reams of hourly mountain weather data produced and archived by the Avalanche Center.

GIS based applications

NWAC's first collaborative effort into geographical informational system display of forecast products is with the GIS department of Western Washington University, who

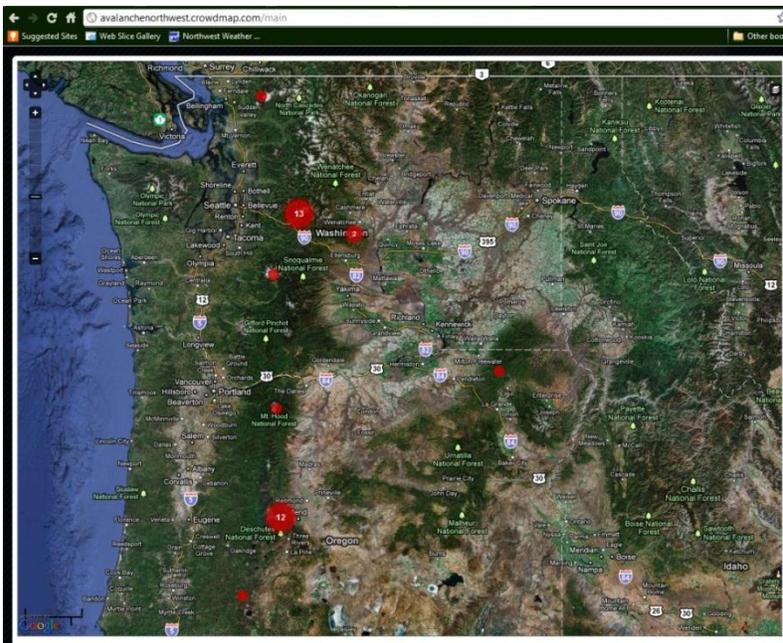


gave an informational presentation on its potential at a monthly FOAC Board meeting this spring. The planned development includes the creation of automatic danger level overlays by elevation and aspect on either a GIS or Google Earth interface, along with

Figure 52. Sample NWAC geographical avalanche danger rose display— developed by Ben Kane and Michael Medler of WWU

an interactive user interface that allows for near real-time geographical plotting and display of a layer of user generated photos, snow profiles, or trip reports. Further collaboration with the WWU GIS professor and graduate student are anticipated over the summer of 2011 with a preliminary version of the informational display planned for unveiling next fall, at least at a basic Tier 1 level. A sample layer mapping of the danger rose information is shown above, with the applicable danger rose in the upper left. As envisioned by the developers, such information would be available for all forecast days along with a slider bar that could be used to scroll back and view past danger roses to help put the present forecast and its evolution in perspective. User or forecaster added info such as avalanche accidents, snowpits, avalanche photos, and other stability info would also show up in another layer as clickable icons on the associated GIS display. However, such geographical mapping of danger rose information must be approached with a great deal of caution and care in any implementation, as a higher resolution geographical display of danger rose information does not include any new information beyond that inherent in the regional danger rose. As a result, zooming in on the geographical danger rose mapping will be limited (the danger level info will disappear at higher zoom levels to be replaced by weather telemetry, snowpack and avalanche observations, photos, and other more site specific information), and in any case should not allow a user to attempt to achieve slope specific danger information from an otherwise regional danger rose product. The most important uses of such a product should be confined to a broad overview of the extent and distribution of avalanche danger(s), and their trends over time, rather than a way to get more specific danger information—no matter how appealing this application may appear. Certainly such a product must balance acceptable precision and accuracy, and should only be presented as a different (more visually appealing?) way of viewing danger rose information rather than a way of gaining more information that has little basis in fact.

Web applications



In other avenues, a variety of programmers and developers have approached both NWAC and the FOAC during the past season with ideas for better and more real-time geographical display of avalanche and weather related information, with some directed toward web site reporting and sharing

Figure 53.
Avalanchenorthwest web site display of avalanche accident and other avalanche related information

of avalanche information and others directed toward smart phone data entry and retrieval.

One of the recent web developments already exists on the internet at <http://avalanchenorthwest.crowdmap.com/main>, and shows recent and updated avalanche accident or other avalanche related information. To quote the mission of this site:

“AvalancheNorthWest (AVNW) is a platform dedicated to promoting avalanche awareness and increasing incident reporting in the Northwest (OR and WA). Use the platform to report and view all avalanche incidents in the NorthWest. Together we can increase incident reporting and enhance our understanding of avalanches, including trends associated with weather as well as the application of avy equipment”.

Smartphone applications

A very promising “Instant Avalanche Information Exchange” development is a rather user friendly iPhone or Android specific application that streamlines and enhances smartphone entry of data such as current weather, snowpack, stability test, photos and other site specific avalanche related information. FOAC and NWAC staff were shown a very interesting and potentially exciting avalanche related smartphone app by Bob Hoffman and Scott Chamberlin (associated with the company ULLR Labs LLC)

Once the app is opened on the web phone, weather and avalanche observations or reports are automatically geotagged by the app with current location (latitude and longitude and elevation), aspect, slope or snow profile inclination. After some easy preliminary info is entered, a full suite of current weather and snow profile entry data is available via clever and quick graphical manipulations of the smart phone touch screen.

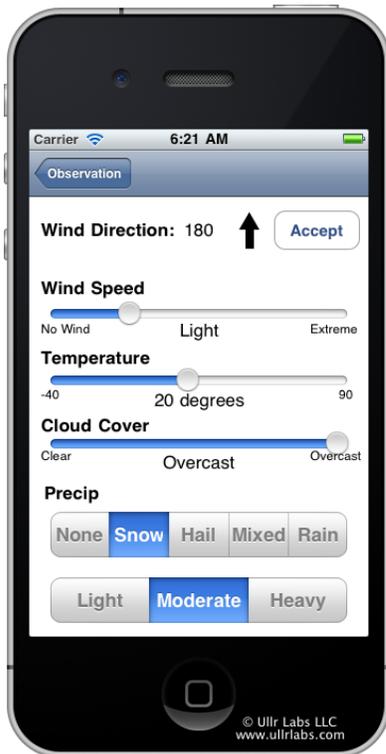


Figure 54. Data entry screen for the Current Weather module

Plotted profiles are instantly available that include layer temperatures, hardnesses, densities, crystal types and grains, along with all of the common snow stability tests (e.g., Rutschblock, Compression, Shovel, Hand, Stuffblock, Extended column, etc) which are also easily user enterable. With the ability to add photos or videos to each report (which is sent to a central regional server), the resulting information can be



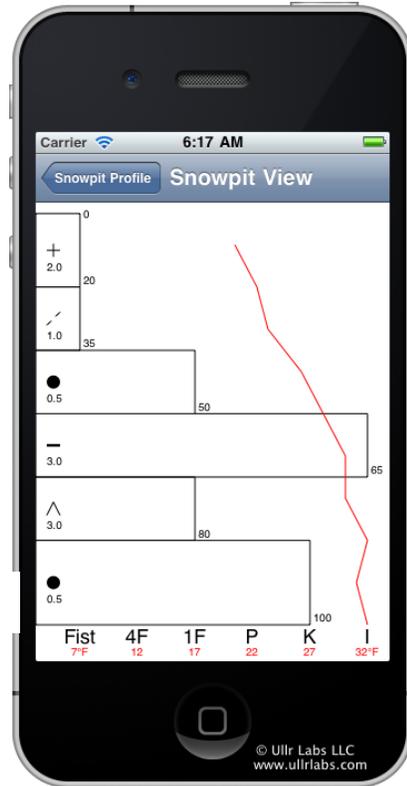
Figure 55. Initial observation entry screen of ULLR smart phone app

instantly available to avalanche forecasters or other users who are notified when new information (within a certain defined radius of their location) becomes available.

Worthy of further mention is the avalanche stability algorithm in the app that analyzes the observational information and adds context sensitive stability or danger level comments or remarks about the stability or slope information entered. The danger guidance integrates information from the US [SWAG](#) (Snow, Weather and Avalanche Guidelines) or other published literature (including [McCammon's lemons approach](#) to snowpack stability parameters) in its list of stability recommendations...with more detailed information about tests and any recommendations only a click away (sort of like having an avalanche reference in the field with you). The accompanying iPhone screen shots from this app give potential users some idea of the data entry methods and the resulting snow profile graphs.

In any case, NWAC and FOAC plan to work with the developers over the upcoming summer in regard to hosting the central regional server for the app database, ensuring that the data entered is easily retrievable and can be added to the existing national SnowPilot database, and that automatic notifications of new data points are sent to requesting users.

Figure 56. Sample plotted snow profile after data entry



Social Media Applications

The Friends of the Northwest Weather and Avalanche Center have developed a well received web presence at [Facebook](#) (over 2,000 followers). This site acts as another informational portal for avalanche related education, activities, announcements, updates etc. for an increasing number of interested users. Seasonal FOAC newsletters are also posted here as well as notes about and updates of avalanche watches, warnings, and other danger related updates. Although NWAC does not administer its own Facebook account, NWAC staff have a [Twitter presence](#) that has become increasingly active over this past year. During the past two seasons, NWAC forecasters have sent out over 100 tweets about both current and anticipated avalanche danger. Despite no links or other public notifications to let folks know about its existence (the NWAC Twitter presence will be announced next fall), NWAC Tweets have attracted an increasing number of followers (almost 150) that include most other regional and local avalanche centers as well as a variety of on-line news services, ski and other winter sports groups. It is believed that in addition to the enhanced NWAC web site, social media offers yet another method to promote avalanche safety and reach interested users who either might not know of the

Avalanche Center's operation or might not wish to spend the time to peruse the site without a compelling reason to do so.

NSAW 2010

Northwest Snow and Avalanche Workshop, 2nd Edition

Based upon the success of the first NSAW in the fall of 2009, 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) again offered a no-cost, one-day mountain weather workshop on September 18th, 2010. The goal of NSAW is to help promote a better understanding and usage of NWAC forecasts and mountain weather in general. 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 those wishing to better understand the often complex relationship between weather and avalanches, such as professional ski patrollers, Search and Rescue personnel and WSDOT avalanche workers.

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 publicly 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. The second offering of the course went well and took advantage of the comments and shortcomings of the inaugural course in 2009. The workshop was again limited to 24 participants and primarily designed for professional avalanche workers and advanced recreational users. Wireless internet access was provided and all participants had access to laptop computers used for the exercises. 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.

Pacific Northwest Mountain Weather Workshop—September 18, 2010

8:00 – 8:15 Introduction(s)

8:15 – 9:00 Weather Basics – Moore

- Heat Engine Earth (a balancing act)
- Circulation patterns
- Lift and topography

9:10-10:00 Forecasting and Model Issues – Moore

- Surface features and development
 - Air masses, High and Low Pressure
 - Frontal structure
 - Precipitation, Temps and Winds
- Topography
 - Wind effects
 - Precipitation effects (synoptic vs. local)
 - Lift, convergence, channeling, blocking

- Temperature effects
 - Inversions, wind flow reversal

10:10-11:00 Field Forecasting & 500 mb flow examples – Moore

- Maps and Models
 - Variable and Variations
 - Ensembles and Spaghetti plots
- 500 mb flow examples – Moore

11:10-12:00 Recent Weather Review and Seasonal Outlook – Moore

- Class Discussion topics (Last spring examples)
- Winter outlook, avalanche danger and the web

12:00-1:00 **LUNCH BREAK**

Afternoon session—Operational Forecasting

1:00-1:50 Checking Reality—Ferber

- Review GFS model, WRF model, NWS public 48 hour forecasts for 12 UTC Saturday 18 Sep 2010
- Verify using satellite, radar, web cams, NWAC weather stations
- Tool Box: ggweather.com, NWS Seattle, UW websites

2:00-2:50 Operational Forecast Exercise—Kramer (Moore, Ferber, Stimberis, Rubin)

- Preparing a short term forecast (mountain vs. flatlands, local vs. synoptic)
 - Getting it right now; extending the present

3:00-3:50 Operational Forecast Exercise (continued) — Kramer (Moore, Ferber, Stimberis, Rubin)

4:00 – END Workshop Wrap—

NSAS 2010

The Northwest Snow & Avalanche Summit (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 other occupations that occur on and around snow. The content of NSAS is relevant to professionals and recreationalists alike.

NSAS is put on by the Alpine Safety Awareness Program. [The Alpine Safety Awareness Program](#) (ASAP) is a community-based effort that uses local resources to teach alpine safety skills to children and adults throughout the Pacific Northwest. ASAP's aim is to save lives and reduce injuries by proactively increasing alpine safety awareness. Since 1999, they have reached more than 30,000 students and adults through their programs. Their goal is to make safety a habit among all winter outdoor enthusiasts.

The 4th annual NSAS was strongly supported with 250 attending the day long event at the flagship [REI Seattle](#) store. A host of commercial vendors were also present in support of the event. This year's presenting speakers included: Dale Atkins, Dr. Bruce

NORTHWEST SNOW AND AVALANCHE SUMMIT

NOVEMBER 7TH 2010

photo: John H. Nairick
design by: Christopher Hill

ANDREI ICEFIELD UNNAMED PEAK, COAST MTHL, BC, CANADA

The Northwest Snow and Avalanche Summit (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 that occur on and around snow. The content of NSAS is relevant to professionals and recreationalists alike.

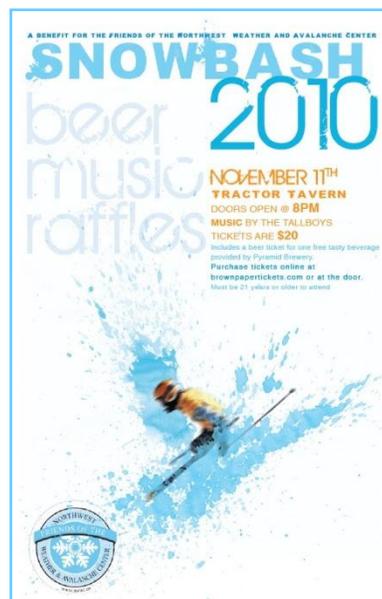
\$39.50 online registration
www.hnowpaperickets.com
\$45.00 at the door
(checks or cash only at the door)
For more information, visit
www.alpinesafety.org

REI Flagship Store
222 Yale Avenue N
Seattle, WA
registration 8:00 am
speakers 8:30 am - 5:00 pm

Jamieson, Garth Ferber, Mark Moore, Brad White and Colin Zacharias.

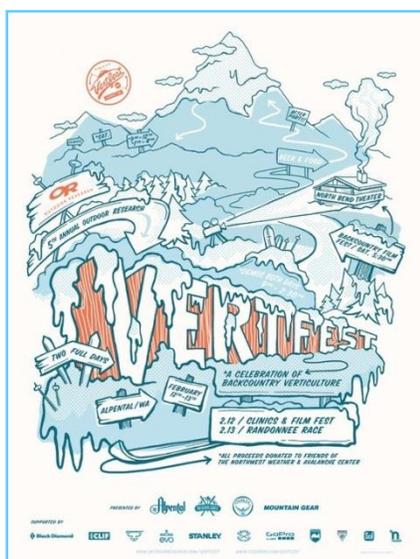
Snowbash 2010

Snowbash followed closely on the heels of a very successful Northwest Snow & Avalanche Summit (NSAS). Snowbash, the annual raucous event that ushers in the Northwest winter and helps to raise the profile of NWAC, hopefully gets folks thinking about avalanches as the backcountry community readies itself for another season. It most definitely is a good time, has found a happy place at the Tractor tavern in Ballard and again featured great live music by [“The Tallboys”](#). It was the umpteenth plus one night of great music, beer drinking, socializing and raffle to raise funds for FOAC. This event grows in popularity each year and 2010 was no exception!



Vertfest 2010

Over the past five years Vertfest has become annual gathering for the Pacific Northwest backcountry ski community. Vertfest offers an opportunity for beginners, adventurers and seasoned pros alike to join together to challenge themselves and celebrate with a weekend of events. Building on the success of years past, a challenging rally course and a popular awards program, [Outdoor Research](#) (the primary sponsor) this year added clinics, demos and a movie night over the course of two days. Participation was up, spirits were high and the weather was good! Of particular note this year was the celebration for a lost member of the backcountry community. Shortly before the Vertfest



weekend, Monika Johnson was killed on Red Mountain by a cornice failure and resulting avalanche. Monika was a strong skier and a consistent winner of the Women's Elite race. Monika was known to carry a stuffed kitty on her pack while skiing. So many racers carried their own stuffed kitties on their packs in memory of Monika.

2011 Vertfest Details:

122 Competitors; 30+ Clinic Participants / Across 7 Clinics; >100 Film Festival Attendees; > 90 Demo Participants; **Raised \$10,000 for FOAC.**



Figure 57.
Vertfest 2011
start line at
Alpental. Photo
G.Ferber



Snowball 2011

*3rd annual Snowball Dinner and Auction
 on April 15, 2011.*

The spring's end-of-the-season celebration and fundraiser for the Northwest Weather and Avalanche Center's support group, FOAC, was held at St. Demetrios Hall in the Montlake neighborhood of Seattle (as it was in 2010). Despite the state of the economy, the event sold out quickly and additional tables were added to

increase the capacity with 275 attendees. FOAC board members with the help of a whole host of volunteer's put on a fantastic evening that is becoming an event not to be missed. Many friends and familiar faces took part in an evening of live and silent auctions, as well as a delicious dinner and much camaraderie. Snowball's proceeds of over \$54,000 shows a high level of dedication and commitment from a large group who value the importance of NWAC and the services it provides. Many thanks and much appreciation go out to all those who help to support NWAC and its efforts.

Other Private Support

In addition to the larger and higher profile events and private support venues listed above, other contributions from the private sector have become increasingly important in helping replace either declining or flat support at the governmental level. Such support includes the following partial list...and for each one we are grateful:

- Mt Hood Meadows President's Day FOAC benefit
 - MT. HOOD, OR – Mt. Hood Meadows Ski Resort added a special night to its operating schedule Monday, February 21, to raise money for the Friends of the Northwest Weather and Avalanche Center, a critical support group for the NWAC and based in Seattle, WA. The resort offered a special \$10 lift ticket good from 3 – 9 PM Monday, February 21. Overall, the event resulted in a \$5,000 donation to the FOAC.
- Mission Ridge Gear Swap
- Fiorini Ski School
- Washington Ski Touring Club

NWAC BUDGET AND FUTURE

Despite slow economic recovery from the recent recession underway at a variety of levels, both the federal and state economies continue to wallow in rather dire straits. This situation has given rise to substantial cutbacks in many governmental programs and services, heretofore deemed critical and sacred (human services, retirement, and education among others). As a result of NWAC's reliance on state and federal funding which comprise approximately 75 % of its budget, a stable operational future for the NWAC remains insecure and rather elusive. Yet even with these associated uncertainties that have plagued the program throughout much of its history, annual and daily NWAC operations that help promote wintertime safety for recreation, transportation and industry in the Northwest have continued without interruption since NWAC's inception in 1975.

Given its history of providing a host of important and professional avalanche and mountain weather related products and services, it remains difficult to understand how the viability of such a popular and critical program remains so tentative. As discussed in several previous NWAC reports, many positive [results and findings](#) have been recently issued about the critical nature of the NWAC program...most resulting from the passage of [SSB 5219](#), a 2007 bill passed by the Washington State Legislature to help 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). To view the many positive conclusions in either the [Berk and Associates Key Findings Report](#) or the complete [WSPRC Final Report](#), please either consult the reports themselves or the summaries given in NWAC Annual Reports for [2009](#) & [2010](#).

However, it is interesting to note that several economic benefits are derived from operation of the NWAC..an especially important consideration during this recent period of economic downturn. Additionally, NWAC—in partner with its important Friends of the Avalanche Center (FOAC) non-profit support group—has made great and increasing strides toward realizing the following recommendations of the Williams' consulting report (contained as part of the [WSPRC Final Report](#) to the Legislature):

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*

In realizing many of these recommendations over the past few years, NWAC has developed (in strong partnership with its cooperators and the FOAC):

- a wide and expanding support base among many committed partners (federal, state and private)
- an expanding awareness, use and support of the service that is exhibited by a growing web presence that includes increasing web site visits, page views and unique visitors year to year (a recent analysis of all US avalanche center web statistics indicated that the NWAC site receives more web visits and unique users than any other center in the US)
- a dedicated staff that continue to expand their skills and knowledge, and work to share this information with the avalanche community
- an expanding suite of trusted products and services that offer reliable, clear and timely information in a responsible and increasingly user-friendly manner (e.g., danger roses, data graphs, GIS applications, mobile apps)
- a strong brand name based on reputation and user experience
- a good operations plan responsive to both users and supporters
- innovative and entrepreneurial strategies that attempt to merge the best attributes of governmental and private partnering, and
- an expanding and increasingly interesting and exciting web site that should soon include GIS based and mobile phone apps to help bring real time avalanche information into the hands of users while in the field, and to forecasters in the office

To achieve the desired result of operating and maintaining the most efficient and useful program possible, the following annual budget figures outline income and expenses for both the current fiscal year (2011) and the outlook year (2012). Note that federal fiscal years extend from October-December of the previous year and January-September of the indicated year— e.g., FY 10 runs from October of 2010 through September of 2011. Please also note that these projections were developed with the additional following assumptions:

- * A small amount of carryover funds are anticipated from FY11 to FY12.
- * Flat support levels are expected to continue from the Forest Service in terms of appropriated monies from the Mt Baker Snoqualmie National Forest.
- * Although flat annual cooperator contributions are shown and projected from the National Park Service, WSPRC and WSDOT, due to continuing issues with the Washington State Budget that are ongoing, WSPRC contributions are by no means assured.
- * While no RAC/Title II monies were received in FY09 and FY10, RAC contributions of \$17,490 were received for FY11. This important source of county support will hopefully be ongoing in the future, but due to the mercurial nature of receiving such support, no RAC monies are projected for FY2012.
- * Unemployment and Medical expenses of approximately \$14,000 in FY08 and prior years have dropped to less than \$1,000 for 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.
- * No COLA salary increases were enacted for FY11 by the federal government; hence salary figures have remained flat for two years. Future federal COLA increases are unknown at this time but have been estimated as 0% through 2012.
- * While FOAC's direct contribution toward NWAC operation is expected to remain at \$5,000, it has either funded or committed approximately \$50,000+ toward development

and expansion (Phases I and II) of the revamped web site which includes the danger rose, data graphs, more user friendly interface and a search utility (soon to be applied). Despite these expenses, it is encouraging to note that advertising on the new FOAC web site has resulted in FOAC revenues of almost \$25,000+/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 including spring forecasts. 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.
- * With a projected average life span of 8-10 year/sensor and capital equipment investment in the field currently reaching upwards of ~\$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. FY11 capital equipment expenditures should help NWAC to purchase and have available some spare sensors to help allow for more prompt field repairs of damaged or broken equipment in the future. However, with about \$40,000 less income currently anticipated for FY12 (if no RAC or other private contributions are received), monies available for capital equipment next year may be dramatically less.

As always it should be noted that the NWAC continues to exist not only because of the direct funding by its many strong cooperators and the strong support of many program users, but also through the many indirect and very important in-kind contributions that help to more completely reflect the overall value of the program. As shown in the following table these indirect monies total well over \$200,000 annually, and result in a program that provides substantially more benefits (about \$600,000 annually) to each cooperator than its individual contributions might otherwise suggest. Although significant carryover from FY10 has enabled NWAC to continue full operation in FY11, a similar carryover into next year is not anticipated. Unfortunately, the projected budget for next fiscal year (FY2012) shown below does not and cannot 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 brainstorming or imaginative funding ideas at the Annual NWAC Cooperator Meeting in early June will tip the tide toward more stable long term funding.

Table 5. Sources of Funding for FY11 and FY12; Total direct and indirect funding.

NWAC Budget—Sources of Funding			
Funding Source	[Direct Support]	FY11	FY12
		[projected]	[projected]
Federal		\$127,000	\$127,000
	USDA-Forest Service	\$75,000	\$75,000
	National Park Service	\$17,000	\$17,000
	USDA-FS Fee Demo	\$35,000	\$35,000
Washington State		\$129,500	\$129,500
	Parks and Recreation Commission (includes State General Fund \$)	\$74,000	\$74,000
	Department of Transportation	\$45,000	\$45,000
	WA Supplemental Budget	\$0	\$0
	Snowpark Program	\$4,500	\$4,500
	Snowmobile Program	\$6,000	\$6,000
County		\$17,490	\$0
	Title II/Resource Advisory Comm.	\$17,490	\$0
Private + Carryover		\$95,588	\$72,501
	PNSAA	\$5,000	\$5,000
	Ski Washington	\$5,000	\$5,000
	NW Winter Sports Foundation	\$15,000	\$15,000
	FOAC ¹	\$20,000	\$15,000
	Other private	\$6,010	\$10,000
	Carryover from FY10 / FY11	\$44,578	\$22,501
TOTAL [Direct Support]		\$369,578	\$329,001
Estimated In-Kind Support (+0% FY11, 0% FY12)		\$234,406	\$234,406
[Indirect support]	USDA-FS (~30% of direct support)	\$30,000	\$30,000
	WSDOT (obs + equip. support)	\$23,883	\$23,883
	NPS (obs + equip. support)	\$5,725	\$5,725
	NWS (office costs + product access etc)	\$69,467	\$69,467
	PNSAA (obs, power, phone etc)	\$7,925	\$7,925
	All (one time cost for data support)	\$63,406	\$63,406
	FOAC (web site development + equip)	\$34,000	\$34,000
GRAND TOTAL [DIRECT + INDIRECT]		\$603,984	\$563,407

¹ FOAC donation shown does not include ~ \$25,000 applied to web site development in FY11 and another ~\$25,000 for avalanche education and other NWAC indirect support (including software and hardware)

Figure 58. NWAC—Projected FY11 Income

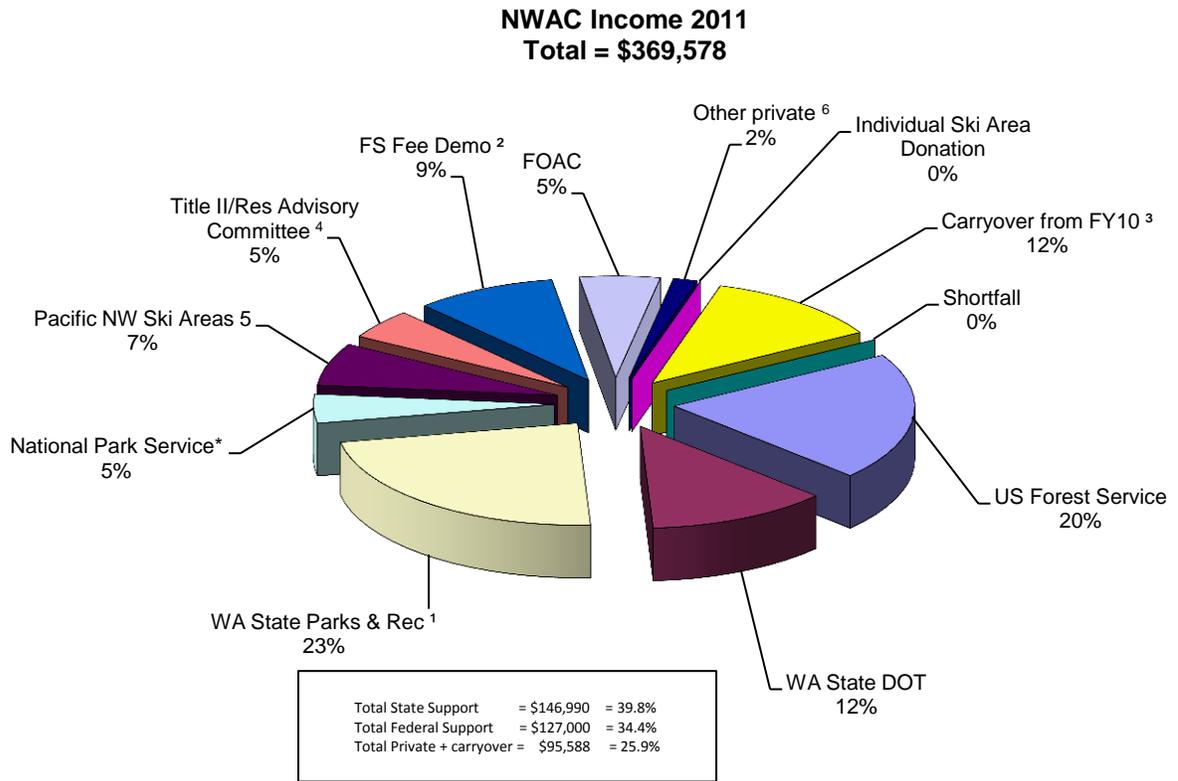
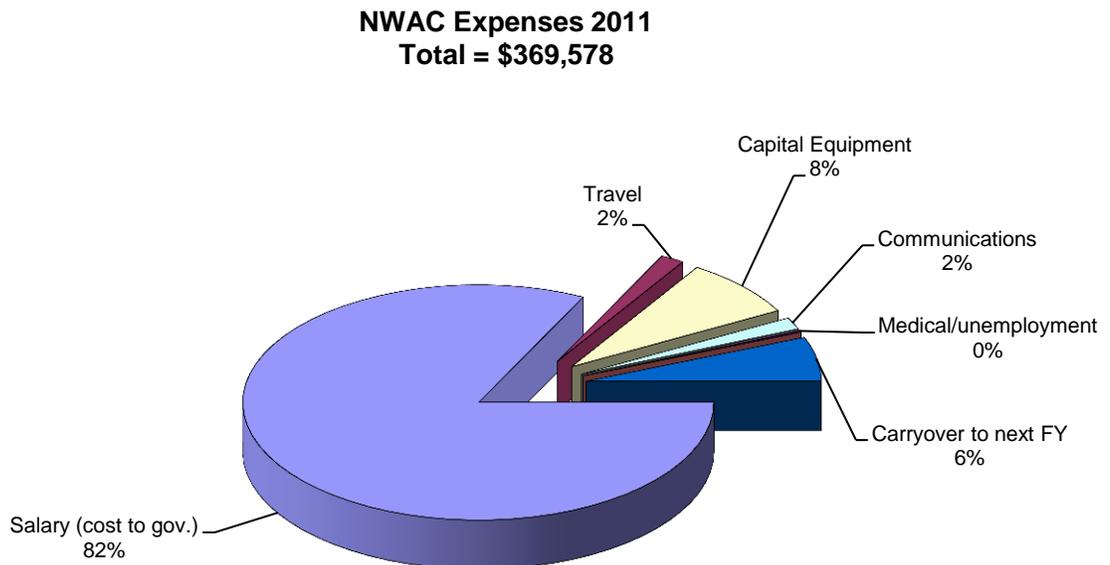


Figure 59. NWAC—Projected FY11 Expenses



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

*Within slopes of deep snow in the Pacific Northwest—
Lives an old snow layer, weaker than the rest.
Formed three months ago, it's long since been buried—
By many feet of snow whose weight it has carried.*

*Now as the layers above grow weaker with melt—
The shear stresses resulting will certainly be felt.
Large slides may release on the old faceted grains—
Involving mud, rocks and trees in the rubble remains.*

*And closer to the surface, there's newer wet weak snow—
Formed in April Fools rain, it may be ready to go.
So use care when you go on than next sun-filled day—
With warm freezing levels and high clouds on the way.
Just takes water and melt penetrating the pack—
And these layers may fail and slide runouts attack.*

*If you're wading in wet snow up to your thigh—
It may be time to retreat or at least to try.
Stability will come, just later this year—
And when it arrives, we'll have much good cheer.*

—Ruminations from May 10 in the PNW—Mark Moore

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