Northwest Weather and Avalanche Center

2007-2008 Annual Report

Report prepared by Mark Moore, Kenny Kramer and Garth Ferber

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

United States Department of Agriculture

Forest Service Pacific Northwest Region

Cover Photo credits:

This large climax slide in White River Canyon to the south of Mt Hood Meadows Ski Area occurred as a result of sustained high winds and heavy loading from late January through early February, 2008. During the thirteen days leading up to this February 8 event, the base of nearby Mt Hood Meadows Ski Area recorded over 160 inches of new snow, along with many periods of sustained very strong winds (averaging 30-50 with higher gusts). Sustained low freezing levels (2-3000 feet or lower) for several weeks prior to the event rose significantly on the day of this avalanche, reaching above 6000 feet. The photo shows Asa Mueller, Mt Hood Meadows Pro Patrol traversing under the 6+ meter crown. It is thought that this large slab was triggered by an even larger (10+ meter) cornice fall (see Figure 28). Photo courtesy Tighe Stoyanoff, Mt Hood Meadows Pro Patrol.

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A MESSAGE FROM THE DIRECTOR

CPC (Climate Prediction Center— www.cpc.ncep.noaa.gov) and NCEP (National Center for Environmental Prediction—www.ncep.noaa.gov) forecasts of a 2007-08 La Niña event provided early season enthusiasm for a great winter in the Northwest. And the abundant winter that developed did not disappoint—offering both the good—excellent powder for much of the season, and the bad—very unstable snow packs and periods of associated high avalanche danger. As is often the case, the good and the bad developed hand in hand, with record setting avalanche fatalities (both in the NW and the US) occurring during a period of phenomenal snowdepth evolution and unusually persistent and low freezing levels from early December into January. As a result of heavy snowfall and strong winds, this late fall and early winter episode brought significant stress on weak layers, plenty of direct action (storm related) avalanche activity, and substantial weakening of the snowpack structure near the base of a progressively deepening snowpack structure. The period also brought intense news media interest in NW avalanche accidents and the winter snowpack, with articles and forecaster interviews appearing in a wide variety of news media sources ranging from the NY Times to Newsweek, NBC to CNN, and NPR to KIRO.

After a brief respite in early-mid January, the winter onslaught resumed in late January through much of February, and then intermittently in March into a cool and relatively wet spring. During a time of year normally characterized by a slowly dwindling snowpack due to spring melt and weakened storm activity, persistent storm activity produced enough new snow to offset typical spring settlement. As a result, NW snow depth charts throughout April and early May presented almost a flat line with any loss in depth due to melt and/or settlement pretty much offset by incoming new snow. With prolonged cool temperatures limiting spring avalanche activity and helping maintain a stronger than normal snowpack for longer than normal, the lack of any sudden and prolonged warmup became an increasing cause for concern. For when it did arrive, the event would have a profound effect on the depth and magnitude of spring avalanche activity—especially when factoring in the faceting and weakening created at the base of the pack in December. This potential stability problem persisted through a cool late April and early May, when it was finally resolved through a spring slide cycle and substantial melt and settlement occurring during a very warm episode in mid-late May. However, new snow instability from an unusually cool and winter-like spring continued into early June, with the last special statement for the 2007-08 season issued on June 10/.

The robust snowfall, widespread news media coverage, and large number of unfortunate avalanche accidents combined to produce intense interest in the NWAC and record setting web site access of NWAC data and forecast products for 2007/08. Even when over 12 million automated data accesses by web "gadgets" are discounted, the numbers of unique visitors utilizing NWAC products was up substantially compared to any prior year (see the discussion and figures in the Information Dissemination section), with well over 4 million hits on data and forecast products. Unfortunately the heavy winter and strong winds took their toll in other arenas as well, destroying phone line access of both the Chinook Pass and Sunrise weather stations for much of the winter, as well as obliterating the wind direction vane at Camp Muir—shearing off both the vane and transmitter spindle. Nevertheless, most weather stations in the data network operated flawlessly for the most part, and the web site experienced increased usage of data from the snow profile and photo page as well as increased accesses to avalanche accident reports and additional links to recent papers, publications and other avalanche or mountain weather related articles.

The value of the Avalanche Center to Washington State, northern Oregon and their residents continues to be underscored by the preliminary recommendations and consultant reports

associated with work outlined by the Washington State Avalanche Center Bill (SSB5219). This bill seeks to establish long term and stable funding for the NWAC, i.e...."It is the intent of the legislature to ensure, in continued cooperation with federal and private sources, that the NWAC receives the resources necessary to continue providing weather and avalanche forecasts for the benefit of Washington State." We continue to be indebted to many interested parties for their interest and work toward establishing the most stable, reliable and meaningful Avalanche Center possible, in particular to the FOAC (Friends of the Avalanche Center), our cooperators, the legislators, the consultants, and the Washington State Parks and Recreation Commission.

*Although such work portends a better Avalanche Center in the future, budget woes in the short term continued to plague the Center's current operation until projected shortfalls for both the current fiscal year (FY08) and next year (FY09) were plugged by increased funding contained in the 2008 Washington State Supplemental Budget. Much gratitude is owed to all who supported this effort and helped make the expanded funding a reality, including the FOAC, state legislators, and Governor Christine Gregoire. —**Mark Moore, Director (June 2008)***

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 mid September to mid-June. The following is a summary of the main NWAC tasks during the 3 distinct parts of our season:

Fall Season (mid September to mid November):

- Plan for upcoming season, discuss priorities and implement changes for better operation and enhanced products.
- Attend and provide input and instruction at the International Snow Science Workshop (ISSW) or 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, WSDOT.

Winter Season (mid November to mid April):

- Provide daily mountain weather and avalanche consultations to ski areas, WSDOT crews and other cooperating agencies, starting at ~3 am, 7 days a week.
- Prepare and disseminate twice daily public mountain weather forecasts (7 am) and daily avalanche forecasts (9 am) 7 days a week; provide updates and special statements as necessary.
- NWAC weather station repairs; ensure 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 requested.
- Prepare and update web site pages with accident and snowpack statistics, and other educational information on weather, snowpack and avalanche awareness.

Spring Season (mid April to mid June):

- Continue to provide mountain weather and avalanche consultations to cooperating agencies, such as WSDOT crews at Washington and Cayuse/Chinook passes.
- Issue special avalanche statements when necessary.
- NWAC weather station upgrades or repairs; continue to provide quality data via the NWAC web site.
- Prepare for and host annual meeting; prepare and issue annual report.
- Plan operations for next season.

INFORMATION EXCHANGE

Incoming Information:

Through the winter NWAC forecasters rely on incoming information and data to make accurate 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 most ski areas, WSDOT crews, and observers at Hurricane Ridge and Paradise on Mt Rainier. Updated observations and spot 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 the Turns-All-Year.com.
- **NWAC Weather Stations:** The NWAC currently maintains or shares maintenance of 44 weather stations located at NPS, WSDOT and ski area sites at Hurricane Ridge in the Olympics and in many locations throughout the Cascade Mountains. These stations provide temperature, relative humidity, wind, precipitation and snowfall information automatically via phone and radio connections.
- **National Weather Service:** NWAC staff has access to all products and expertise of the National Weather Service Seattle office, including their data and forecast product displays available via AWIPS (Advanced Weather Information Processing System).

Outgoing Information:

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

- **Phone Consultations**: at least once daily with most ski areas, DOT crews at Stevens and Snoqualmie Passes, and observers at Paradise, Mt Rainier National Park. Consultations increase to multiple times/day during periods of rapidly changing weather and avalanche conditions.
- **Public Hotline Phone Recordings**: in Seattle and Portland. Overall the number of calls to the recorders has decreased as the use of Internet access has skyrocketed (Figure 2); however hot line usage during this past year increased to over 10,000 for the first time since 2002.
- **Internet**: Visitors and unique visits to the NWAC web site have greatly increased over the past few seasons, as indicated below in Figures 3 and 4, with almost every year producing a new record in terms of visits/accesses and product hits. See Figure 1 for a weekly access breakdown and Figure 2 for an annual tally of product hits that now reaches between 3.5 and 4.5 million/year (not including over 16 million automated hits this past year on NWAC data products generated by web sidebars or gadgets). On average the NWAC web site receives from around 20,000 to over 40,000 hits/week on forecast products during the core of the forecast season (early December through late March), and from 150,000 to 250,000 hits/week on data and forecasts (weekly maximum of almost 1 million—just over 961,000—hits/week if automated "gadget" data hits are included). Note that these figures still represent the "tip of the usage iceberg", as a variety of other web sites download data and forecasts and either make them locally available on other servers or provide an email product for subscribers. Figures 3 and 4 show a rather amazing increase in unique visitors and overall file accesses to the site during this past year.
- **NOAA Seattle Weatherwire**: NWAC products are also distributed to the media and commercial vendors via the Weatherwire service. As begun in the 2006/07 winter, to help increase danger awareness of "avalanche warning" situations (high or greater danger at or below 4000 feet in the Washington Cascades or Olympics and 5000 feet in the Mt Hood area), NWAC forecasters are continuing to collaborate with the National Weather Service to add an "Avalanche Section" to the highly popular and nationally distributed NWS Area Forecast Discussion (AFD) product. An example of this product

issued to highlight potential future closure of all the passes in the state is shown below with the avalanche portion highlighted:

FXUS66 KSEW 031815
AFDSEW
AREA FORECAST DISCUSSION...UPDATED TO INCLUDE AVALANCHE SECTION NATIONAL WEATHER SERVICE SEATTLE WA
1015 AM PST SUN FEB 3 2008
.SYNOPSIS...A SMALL WEAK UPPER LEVEL RIDGE WILL MOVE OVER WESTERN WASHINGTON TODAY BRINGING DRY WEATHER AND SOME SUNBREAKS THIS AFTERNOON. CLOUDS WILL INCREASE LATER TONIGHT AS A WARM FRONT APPROACHES THE COAST. THE WARM FRONT WILL BRING INTERMITTENT VERY LIGHT RAIN TO MAINLY THE COAST MONDAY MORNING WITH LIGHT RAIN SPREADING INLAND MONDAY AFTERNOON. A STRONG COLD FRONT WILL CROSS THE AREA TUESDAY BRINGING RAIN...WIND...AND HEAVY SNOW IN THE MOUNTAINS. ANOTHER FRONTAL SYSTEM WILL ARRIVE LATE WEDNESDAY INTO THURSDAY. WET WEATHER WILL CONTINUE INTO NEXT WEEKEND.
&&
.SHORT TERM...RADAR AND OBS SHOW DRY WEATHER FOR A CHANGE THIS MORNING. A DENSE BUT PROBABLY SHALLOW ALTOCU DECK FORMED OVERNIGHT THROUGHOUT W WA BETWEEN 6500-8000 FEET. THIS LAYER LIKELY DELAY ANY SUNBREAKS UNTIL THIS AFTERNOON. WILL BELAY A ZONE AMENDMENT SINCE IT WOULD ONLY PLAY WITH THE WORDING OF THE FORECAST.
GFS/NAM HAVE BEEN TRENDING A LITTLE SLOWER WITH THE ARRIVAL OF THE WARM FRONT ON MONDAY. WILL CUT BACK POPS FOR TONIGHT AND GO DRY EVERYWHERE. CURRENT POP GRIDS FOR MONDAY LOOK FINE...BUT THE RAIN WILL BE VERY LIGHT AND PROBABLY NOT START INLAND UNTIL AROUND MID AFTERNOON. QPF MONDAY WILL PROBABLY AMOUNT TO A FEW HUNDREDTHS OR LESS. WILL DO SOME ZONE REWORDING FOR THE AFTERNOON PACKAGE. GFS SHOWS THE STRONGEST WARM ADVECTION DELAYING UNTIL MONDAY NIGHT SO THE INTERMITTENT DRIP WILL CONTINUE.
SLOWER MODEL TREND ALSO APPLIES TO TUESDAYS STRONG COLD FRONT. 12Z NAM NOW ADVERTISES A MIDDAY FROPA FOR PUGET SOUND. THE UPPER LEVEL TROUGH THAT DEVELOPS INTO THIS FRONT IS CURRENTLY OUT NEAR 35N/180W. ASIDE OF THE TIMING ISSUE...GFS/NAM/ECMWF HAVE ALL BEEN AMAZINGLY CONSISTENT WITH THIS FRONT. THIS IS STILL SHAPING UP TO BE THE STANDARD SE WIND SYSTEM...LIKELY WIND ADVISORY LEVEL FOR THE N INTERIOR. BIGGEST PROBLEM APPEARS TO BE ANOTHER LOAD OF SNOW FOR THE MOUNTAINS. 12Z NAM12 HAS ABOUT 0.60 QPF WITH THE FRONT UP THROUGH 00Z WED...THEN DUMPS ANOTHER 1.00+ FROM THE STRONG WESTERLY POST-FRONT FLOW IN THE NEXT 12 HOURS THROUGH 12Z WED. THAT SHOULD BE ANOTHER EASY FOOT AND A HALF OF SNOW. KAM
.LONG TERM...BOTH GFS/ECMWF STILL MAINTAIN A STRONG W JET OVER THE NE PACIFIC INTO NEXT WEEKEND. THIS BLOWS ANOTHER SOMEWHAT WEAKER COLD FRONT THROUGH THE AREA LATER WEDNESDAY...FOLLOWED BY ANOTHER 24 HOUR PERIOD OF STRONG W FLOW...AND PROBABLY ANOTHER FOOT+ SIZED DUMP OF MOUNTAIN SNOW. GFS HAS BEEN SHOWING STRONG WARM ADVECTION WITH RISING SNOW LEVELS FRIDAY...BUT ECMWF IS WEAKER. IF GFS IS RIGHT THIS COULD MEAN ADDING RAIN AT LOWER ELEVATIONS TO THE PREVIOUS DUMPS OF SNOW. THIS MAY BE MORE CLEAR IN A DAY OR SO. MODELS HAVE BEEN CONSISTENT THROUGH ABOUT THURSDAY...SO CONFIDENCE IS FAIR...AT LEAST THROUGH THE 2ND FRONTAL SYSTEM THIS WEEK AND THE SUBSEQUENT STRONG W FLOW. KAM
&&
.AVIATION...AN UPPER TROUGH OVER THE WESTERN U.S. INTERIOR WILL CONTINUE MOVING INLAND. NW FLOW ALOFT OVER WESTERN WA. NORTHERLY SURFACE GRADIENTS OVER MOST OF THE AREA WILL WEAKEN LATE TODAY...AND SOUTHERLY GRADIENTS WILL DEVELOP TONIGHT AS A WEAK WARM FRONT APPROACHES THE COAST MON. THE AIR MASS WILL REMAIN STABLE AND MOIST. VFR CONDITIONS ACROSS MOST OF THE FORECAST AREA THIS MORNING. LOCAL MVFR FROM KBFI INTO THE S SOUND TIL NOON. CEILINGS SHOULD RISE ABOVE 12000 FT TONIGHT.
AT KSEA...NORTH WIND 4-7 KT BACKING TO SOUTHERLY LATER TONIGHT. BUEHNER
&&
.MARINE...NORTHERLY SURFACE GRADIENTS ACROSS THE FORECAST AREA WILL EASE THROUGH TONIGHT AS A SURFACE RIDGE OFFSHORE MOVES CLOSER. THE RIDGE SHOULD WEAKEN AND MOVE INLAND EARLY MON AS A WARM FRONT APPROACHES THE FORECAST AREA. THE WARM FRONT IS EXPECTED TO REACH THE COASTAL WATERS MON AFTERNOON AND LIFT NORTHEAST MON NIGHT. THE ASSOCIATED STRONG COLD FRONT WILL THEN SWING ONSHORE TUE FOLLOWED BY STRONG ONSHORE FLOW TUE NIGHT. IT LOOKS LIKELY THAT THIS SYSTEM WILL GENERATE SOUTHERLY GALES LATE MON NIGHT AND TUE AND THEN GALE WESTERLIES DOWN THE STRAIT BEHIND THE FRONT. ANOTHER STRONG FRONTAL SYSTEM WILL AFFECT THE FORECAST AREA WED AND THU WITH GALE FORCE WINDS AGAIN LIKELY. BUEHNER
&&
.AVALANCHE...DECREASING SHOWERS AND WINDS COMBINED WITH INCREASING SNOWPACK SETTLEMENT HAVE ALLOWED AN END TO THE RECENTLY UNENDING AVALANCHE WARNING IN EFFECT MUCH OF MID-LATE LAST WEEK. ALTHOUGH CONSIDERABLE TO HIGH DANGER STILL PERSISTS AND REQUIRES MUCH CAUTION IN THE BACK COUNTRY...IT IS GOOD FOR THE SNOWPACK TO RELAX A LITTLE...EVEN IF VERY SLOWLY. UNFORTUNATELY MORE WORRISOME THAN THE STILL TROUBLING PRESENT AVALANCHE DANGER IS THE FAIRLY CONSISTENT MODEL TREND TOWARD A RETURN TO EVEN STRONGER AND VERY MOIST WESTERLY FLOW TUESDAY THROUGH THURSDAY FOLLOWED BY WARMING AND CONTINUED HEAVY

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PRECIPITATION MID-LATE FRIDAY. IF ALL THIS VERIFIES...AND THE POTENTIALLY LARGE
AMOUNTS OF WIND DRIVEN SNOW FALL ON MORE WEAK LAYERS AND OUR STILL WEAK UPPER
SNOWPACK...MORE PASS CLOSURES AND HIGH TO EXTREME DANGER LOOK PROBABLE. SEE NWAC.US
FOR DETAILS. MOORE
&&
.SEW WATCHES/WARNINGS/ADVISORIES...
.SMALL CRAFT ADVISORY COAST.
$$
WEATHER.GOV/SEATTLE
```

- **Search and Rescue Assistance:** The NWAC provides weather and avalanche forecast assistance to County Search and Rescue teams as necessary.
- **NWAC mountain weather station data:** Data for the past 18 years is available upon request.

Figure 1. Weekly forecast and data access on NWAC web site, 2007-08.

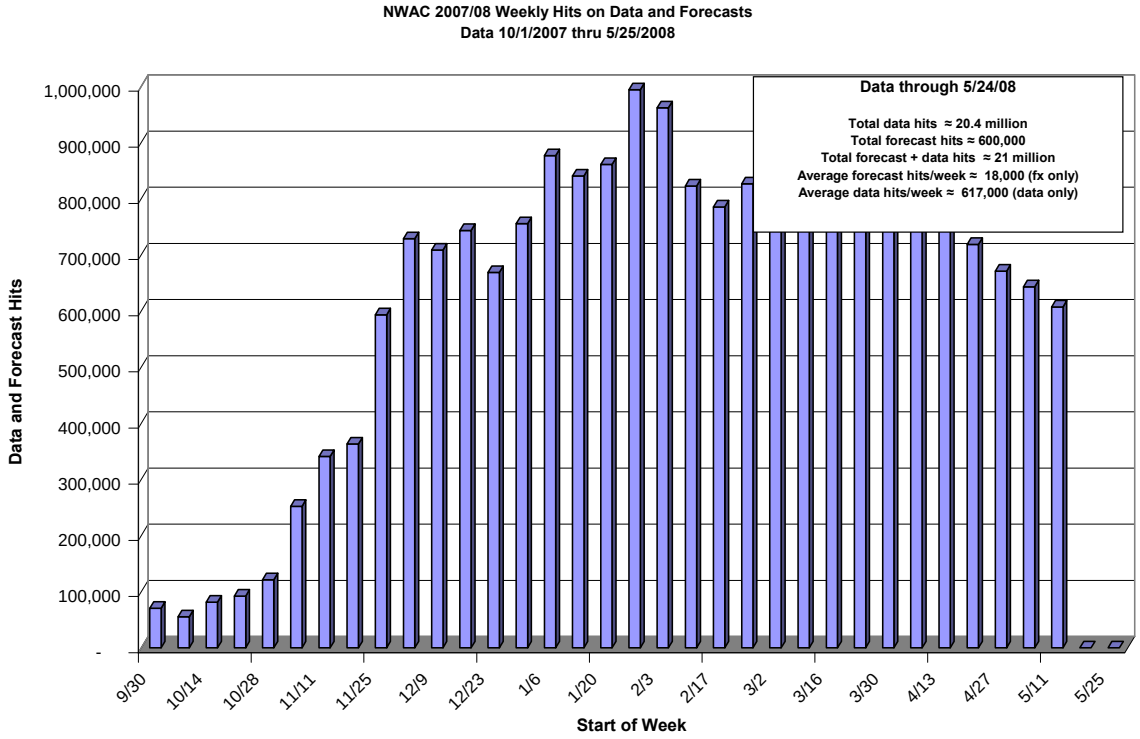


Figure 2. NWAC data and forecast dissemination over the past 14 years.

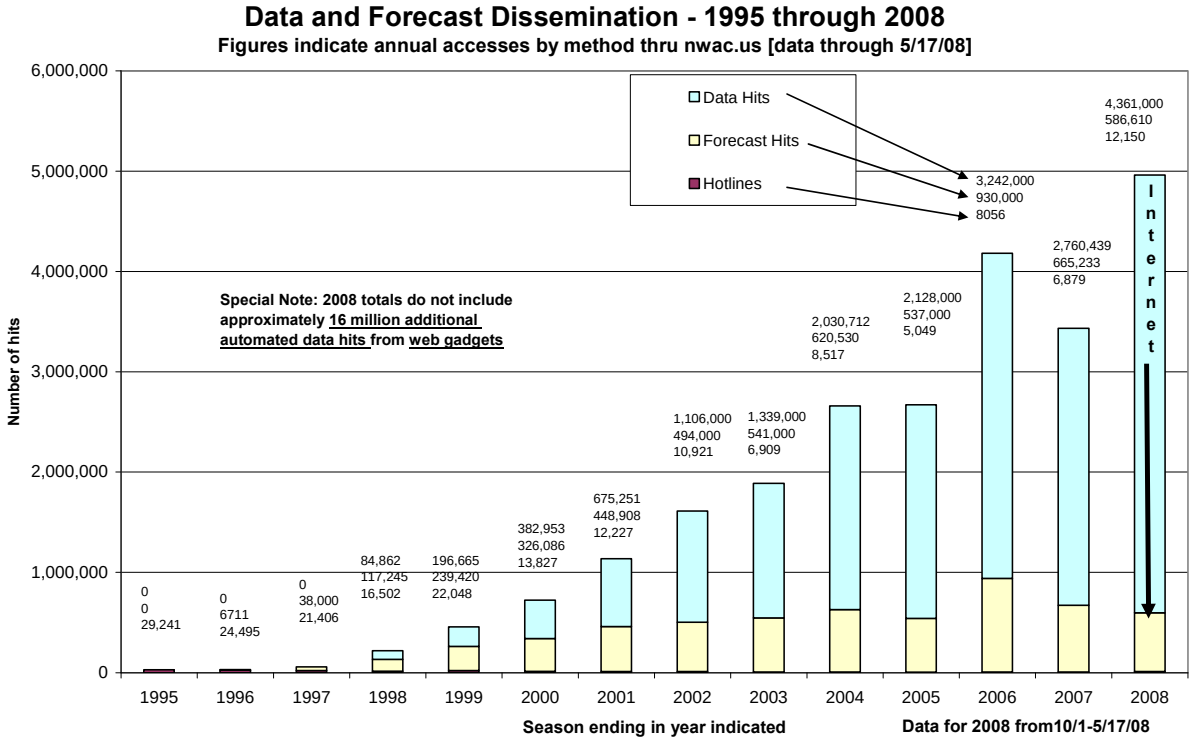


Figure 3. Annual plot of unique visitors to NWAC web site by week, 2004-2008

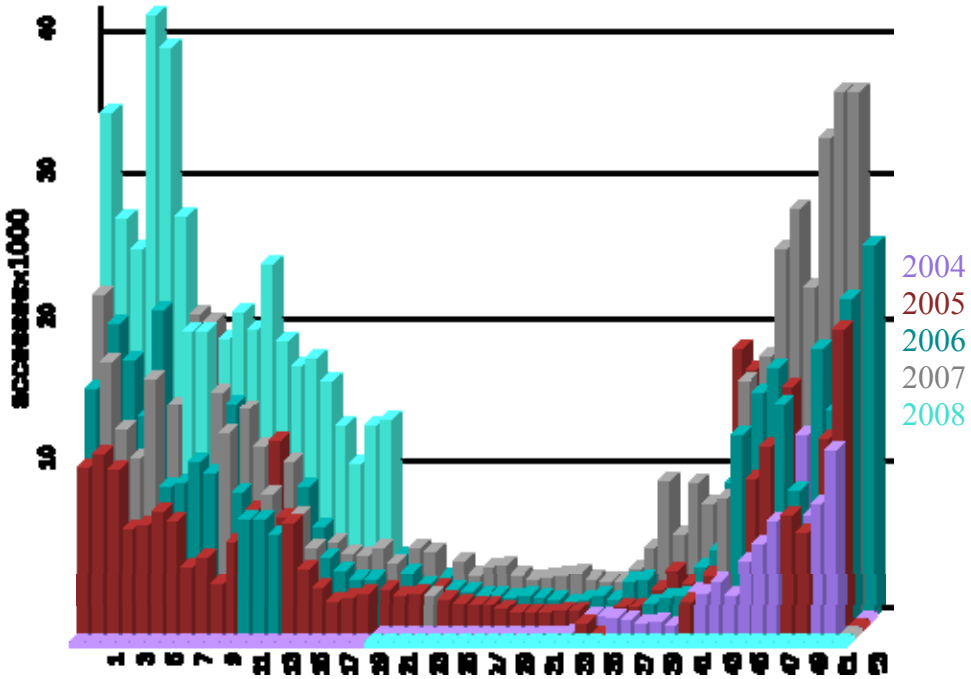
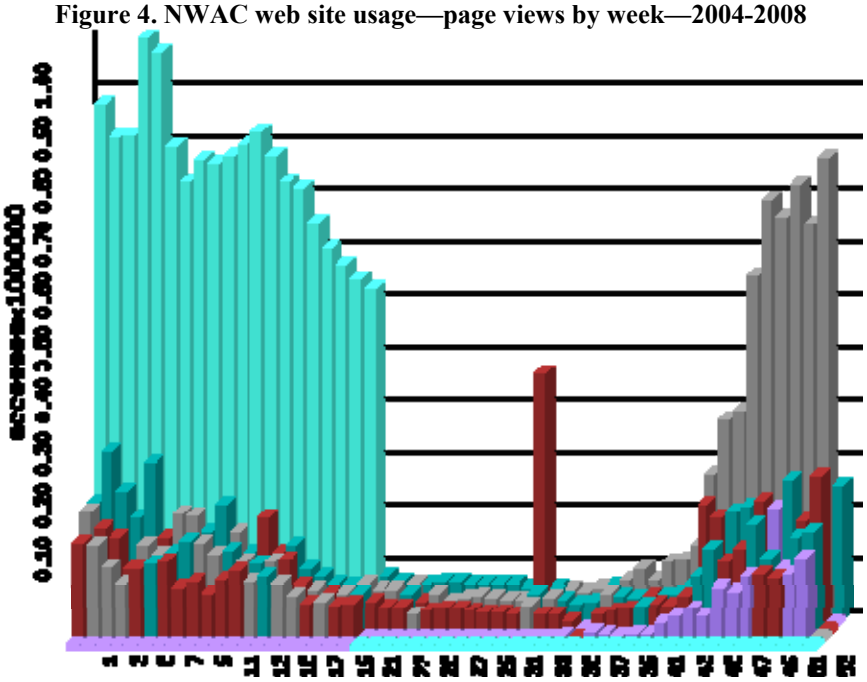


Figure 4. NWAC web site usage—page views by week—2004-2008



2007-2008 LA NIÑA

After indicating development of a weak La Niña (cold event) late last summer into the early fall, late fall analyses and winter forecasts by the National Center for Environmental Prediction (NCEP—http://www.cpc.ncep.noaa.gov/products) indicated that this event should evolve into a moderate to strong La Niña. And this is pretty much what happened during the late fall, winter and spring of 2007/08.

2004
2005
2006
2007
2008

So what is La Niña and what sort of atmospheric circulation results from a moderate to strong La Niña in a typical Northwest winter? To quote NCEP,

> "At times ocean surface temperatures in the equatorial Pacific are colder than normal. These cold episodes, sometimes referred to as La Niña episodes, are characterized by lower than normal pressure over Indonesia and northern Australia and higher than normal pressure over the eastern tropical Pacific. This pressure pattern is associated with enhanced near-surface equatorial easterly winds over the central and eastern equatorial Pacific."

In addition, NCEP describes its primary effects on North America as:

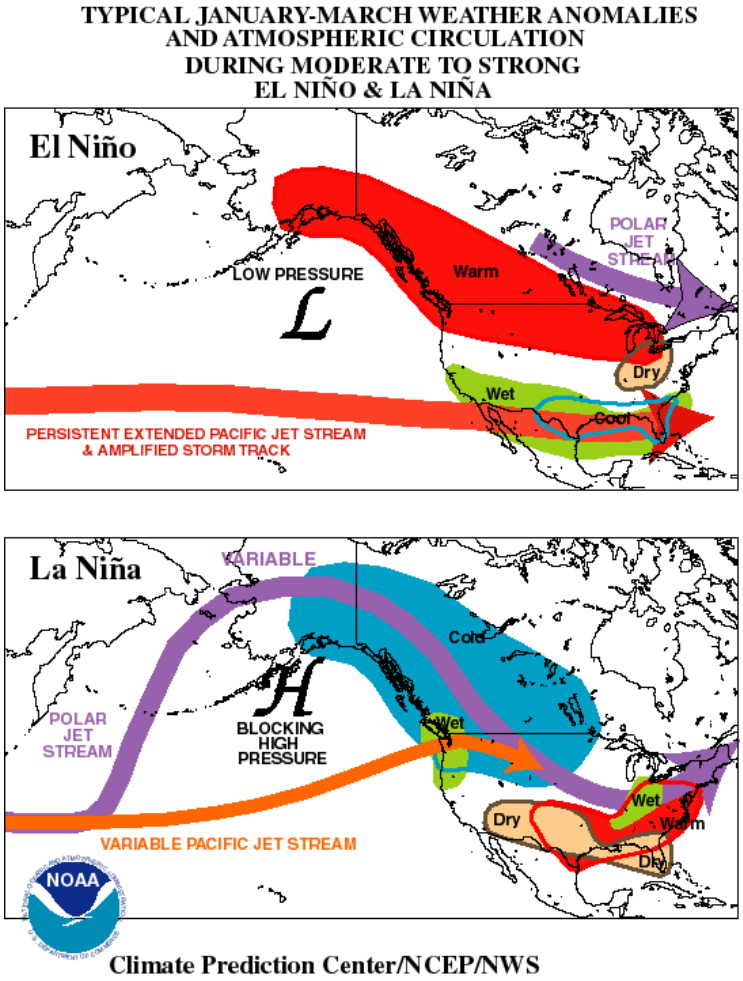
> "During cold (La Niña) episodes the normal patterns of tropical precipitation and atmospheric circulation become disrupted. The abnormally cold waters in the equatorial central give rise to suppressed cloudiness and rainfall in that region, especially during the Northern Hemisphere winter and spring seasons. At the same time, rainfall is enhanced over Indonesia, Malaysia and northern Australia. Thus, the normal Walker Circulation during winter and spring, which features rising air, cloudiness and rainfall over the region of Indonesia and the western Pacific, and sinking air over the equatorial eastern Pacific, becomes stronger than normal.

By studying past cold episodes scientists have discovered precipitation and temperature anomaly patterns that are highly consistent from one episode to another. Significant departures from normal are shown in the accompanying figures for the Northern Hemisphere winter and summer seasons. During cold episodes, the colder than normal ocean temperatures in the equatorial central Pacific act to inhibit the formation of rain-producing clouds over that region. Wetter than normal conditions develop farther west over northern Australia, Indonesia and Malaysia, during the northern winter, and over the Philippines during the northern summer. Wetter than normal conditions are also observed over southeastern Africa and northern Brazil, during the northern winter season. During the northern summer season, the Indian monsoon rainfall tends to be greater than normal, especially in northwest India. Drier than normal conditions during cold episodes are observed along the west coast of tropical South America, and at subtropical latitudes of North America (Gulf Coast) and South America (southern Brazil to central Argentina) during their respective winter seasons.

Mid-latitude low pressure systems tend to be weaker than normal in the region of the Gulf of Alaska, during a cold episode winter. This favors the build-up of colder than normal air over Alaska and western Canada, which often penetrates into the northern Great Plains and the western United States. The southeastern United States, on the other hand, becomes warmer and drier than normal."

The above yellow highlighted impacts on the United States can be more completely understood by the expected average positions of the polar/Pacific jetstream during a La Niña event (see the Figure below).

Figure 5. Typical Circulation Patterns with moderate to strong La Niña and El Niño



When the jetstream lies along the lower (red) track shown above in the lower (La Niña portion), gloriously rainy/snowy Northwest weather brings delight to both woodland creatures and lovers of Cascade crud. However, when a blocking upper ridge graces the Gulf of Alaska as in the blue flow pattern above, the resulting north to northwesterly path of the jetstream brings cooler and generally drier weather to the region. When the warmer and wetter pattern in red follows the colder pattern in blue, the NW mountains can and do experience some rapid temperature fluctuations that result in dramatically changing and high to extreme avalanche danger (cold, lower density snow or surface hoar followed by large and increasing density snowfall or rain.

Hence overall La Niña normally typically brings with it an increased chance for slightly wetter and cooler weather to the region. However, before rejoicing that "abundant powder will be there for the taking" during La Niña winters, we need to bring in a slightly more sobering scenario that considers the influence of La Niña combined with the overall slow global warming trend with which we are all aware. While late fall and early winter conditions still may exhibit (statistically) a slight bias toward wetter and colder conditions in the NW, this bias is shown to deteriorate to more normal (ENSO-neutral) or even slightly warmer than normal conditions as the winter progresses, especially if one considers a weak (or even a weak to moderate) La Niña combined with global warming. Fortunately the strength of this past winter's La Niña was sufficient to continue producing a dramatic cooling effect on NW weather into early-mid spring. And how about precipitation-wise considering the combined La Niña/global warming trend? For some La Niña winters, the effect for this combination may be to shift the heaviest 3 month average precipitation southward into Oregon and northern California, rather than keeping it centered from northern California through northern Washington.

The global influence of such a moderate to strong La Niña event is shown below, with the overall cool and wet influence shown over the northwestern US, and the cooler than normal regime extending from Alaska through much of western Canada.

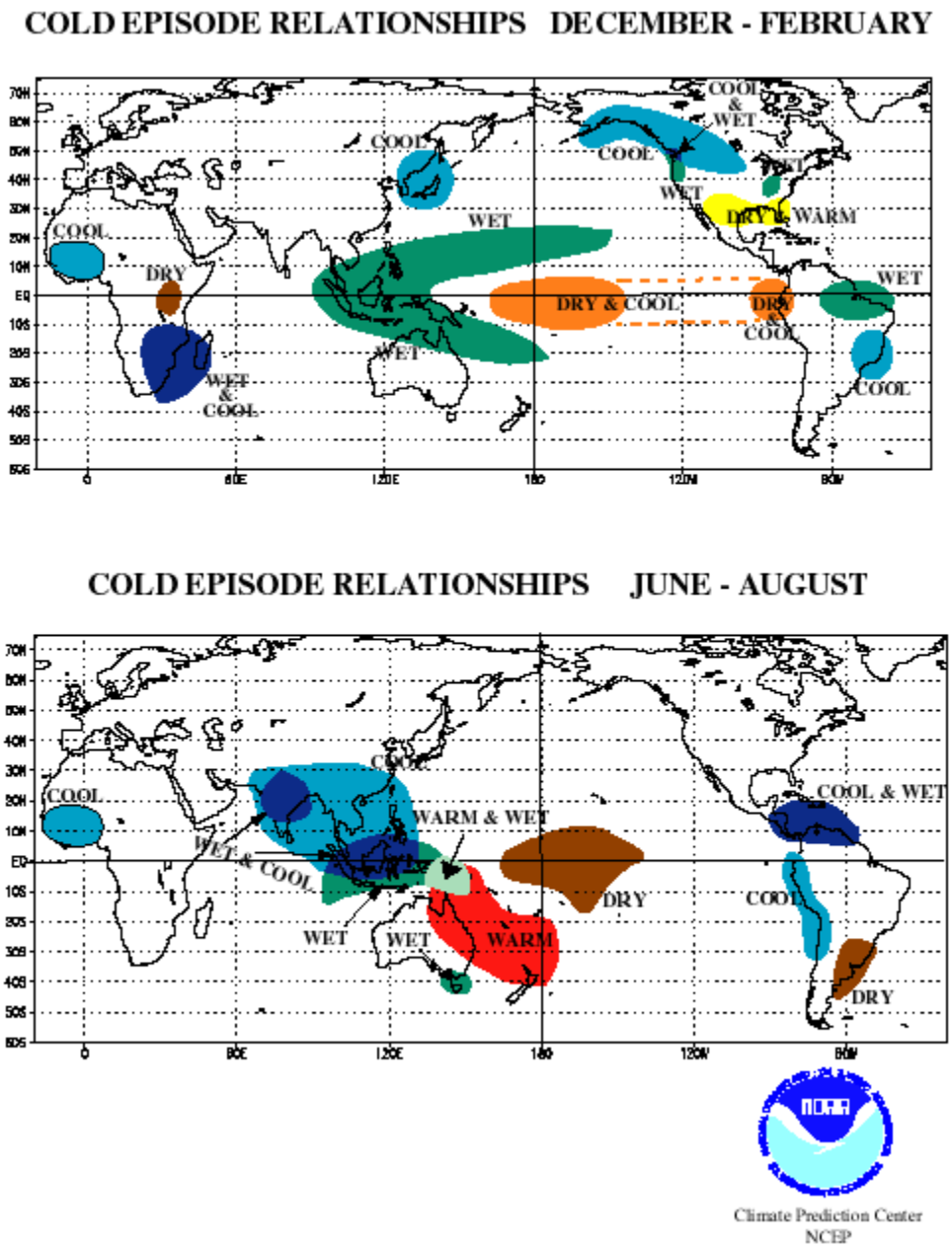


Figure 6. Cold episode relationships by season

And how often does a La Niña occur? To answer this it must be noted that El Niño and La Niña events are often classified by a number of different criteria. Some classification systems use the strength and sign of the Southern Oscillation Index (SOI), while others use Sea Surface Temperature (SST) anomalies for a variety of Pacific regions. Still others use a combination of several criteria to gauge the type and strength of the event. Consequently there are number of different lists which are actively used. Four of the most widely used lists are:

- Western Region Climate Center at http://www.wrcc.dri.edu/enso/ensodef.html
- Climate Diagnostics Center at http://www.cdc.noaa.gov/ENSO

- Climate Prediction Center at http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/ensostuff/ensoyears.shtml
- Multivariate ENSO Index from Climate Diagnostics Center at: http://www.cdc.noaa.gov/ENSO/enso.mei_index.html

In the web site http://ggweather.com/enso/oni.htm (and the older now no longer updated site at http://ggweather.com/enso/years.htm) ENSO event consensus was arrived at by choosing years which appeared on three of the four above lists. In this list, there is obviously some crossover of the variables used in the various methodologies and no attempt has been made to give a weight of one list over another. When WRCC, CPC and MEI all indicated W+ and CDC gave a W (their strongest category) then that season was considered a strong event. Otherwise the strength was determined from the "average" of the strength of chosen events. The resultant data is expressed in Table 1 (below), where W- = weak El Niño, W = Moderate El Niño, W+ = strong El Niño, and similarly with cold events (La Niña).

Table 1. Consensus List of El Niño and La Niña Years

Winter	WRCC	CDC	CPC	MEI	Consensus
1950-51	C+	C	C	C	La Niña
1951-52	W+		W-		
1952-53					
1953-54	W		W-		
1954-55			C	C-	
1955-56	C+		C+	C	Strong La Niña
1956-57	C		C-	C-	Weak La Niña
1957-58	W	W	W+	W	El Niño (moderate)
1958-59			W+	W-	
1959-60					
1960-61					
1961-62				C-	
1962-63				C-	
1963-64	W		W-		
1964-65	C		C	C-	La Niña
1965-66	W+	W	W	W	El Niño (moderate)
1966-67				C-	
1967-68				C-	
1968-69			W	W-	
1969-70	W		W		
1970-71	C		C	C	La Niña
1971-72	C		C-	C-	Weak La Niña
1972-73	W+	W	W+	W	Strong El Niño
1973-74	C+	C	C+	C+	Strong La Niña
1974-75	C		C-	C-	Weak La Niña
1975-76	C+	C	C+	C	Strong La Niña
1976-77	W		W-		
1977-78	W+		W-	W-	El Niño (weak to moderate)
1978-79					

1979-80			W-	W-	
1980-81					
1981-82					
1982-83	W+	W	W+	W+	Strong El Niño
1983-84			C-		
1984-85			C-	C-	
1985-86					
1986-87			W	W	
1987-88	W+	W-	W	W-	El Niño (moderate)
1988-89	C+	C-	C+	C	Strong La Niña
1989-90					
1990-91			W+		
1991-92	W	W	W+	W+	Strong El Niño
1992-93	W		W+	W-	El Niño (moderate)
1993-94	W+		W		
1994-95	W+		W	W-	El Niño (moderate)
1995-96			C-	C-	
1996-97					
1997-98	W+	W	W+	W+	Strong El Niño
1998-99	C+		C	C-	La Niña
1999-00			C	C	
2000-01	C	C	C-	C-	La Niña
2001-02					
2002-03	W	W	W	W	El Niño (moderate)
2003-04					
2004-05	W	W	W-	W/W-	El Niño (weak to moderate)
2005-06					
2006-07	W	NA	NA	W/W-	El Niño (weak to moderate+?)
2007-08		C	C+	C	La Niña (moderate to strong)

How do the moderate to strong or even weak to moderate La Niña winters of the past 20-30 years stack up against overall climatology for some key NW mountain sites? For informational purposes the plots of representative sites in the NW are shown below from north to south: Mt Baker, Stevens Pass, Mission Ridge, Snoqualmie Pass, Crystal Mt, Paradise (Mt Rainier), White Pass, and Mt Hood Meadows (figures updated through May 1, 2008). As previously mentioned, these graphs indicate overall higher or even significantly higher than normal snowfall and associated snow depths during stronger La Niña events.

Figure 7. Mt Baker snow depths vs climatology and La Niña years

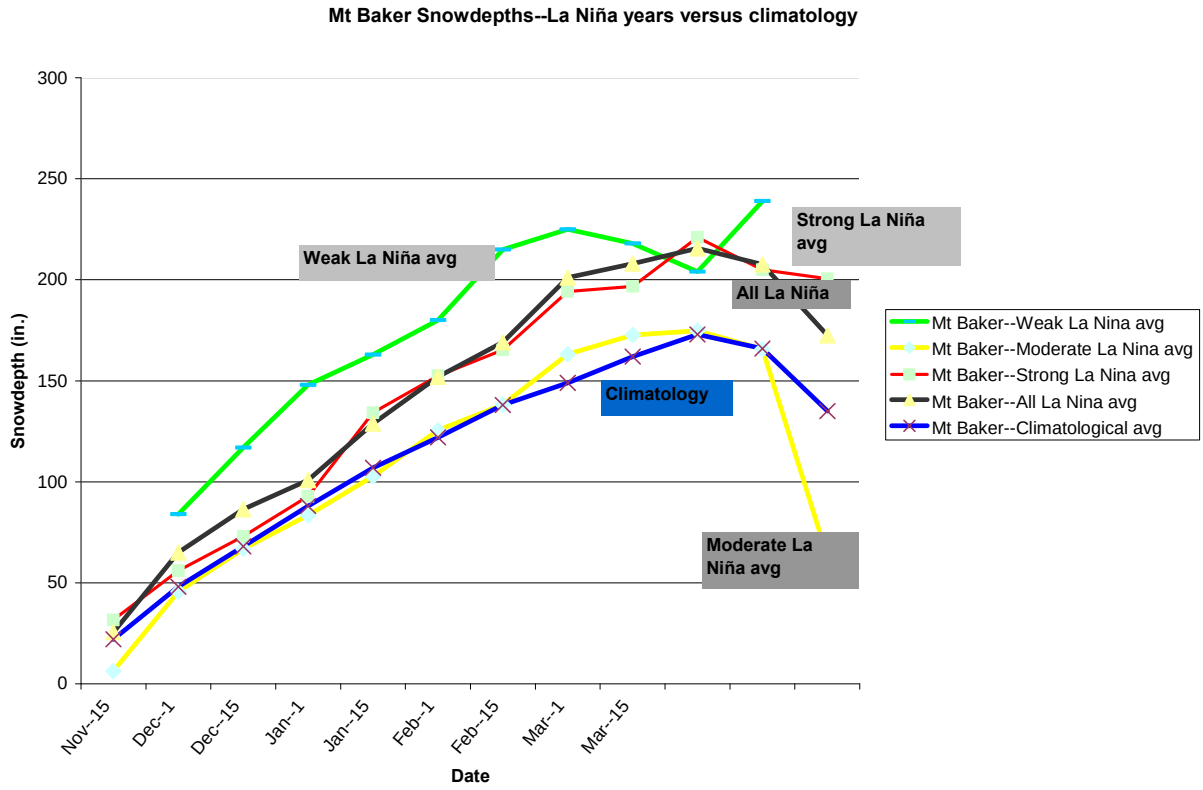


Figure 8. Stevens Pass snowdepths vs climatology and La Niña years

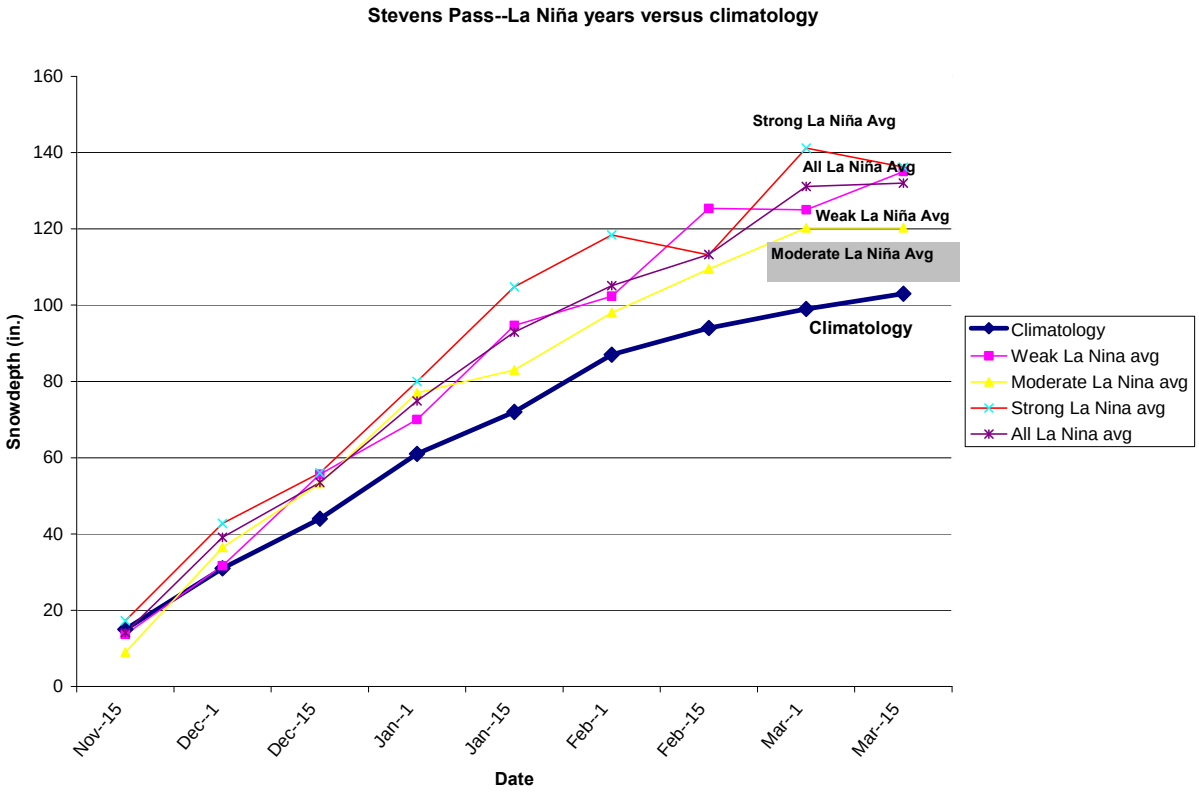


Figure 9. Mission Ridge snowdepths vs climatology and La Niña years

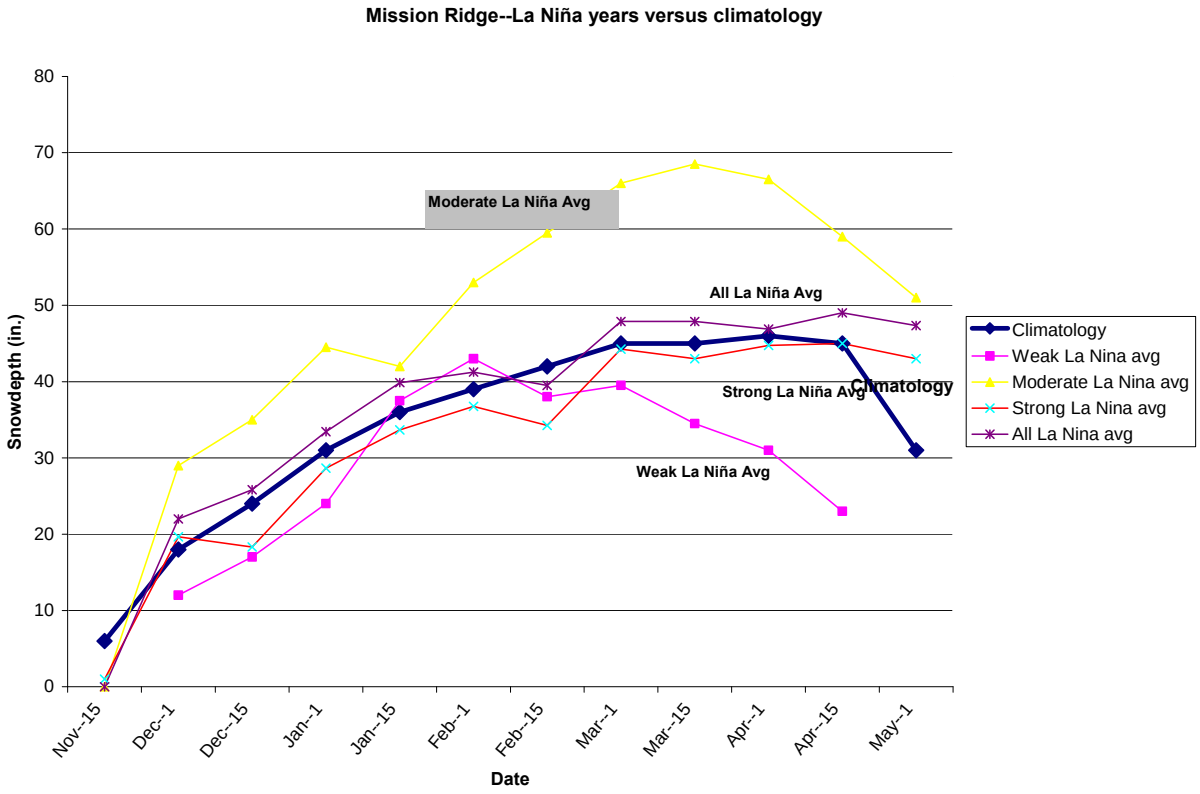


Figure 10. Snoqualmie Pass snowdepths vs climatology and La Niña years

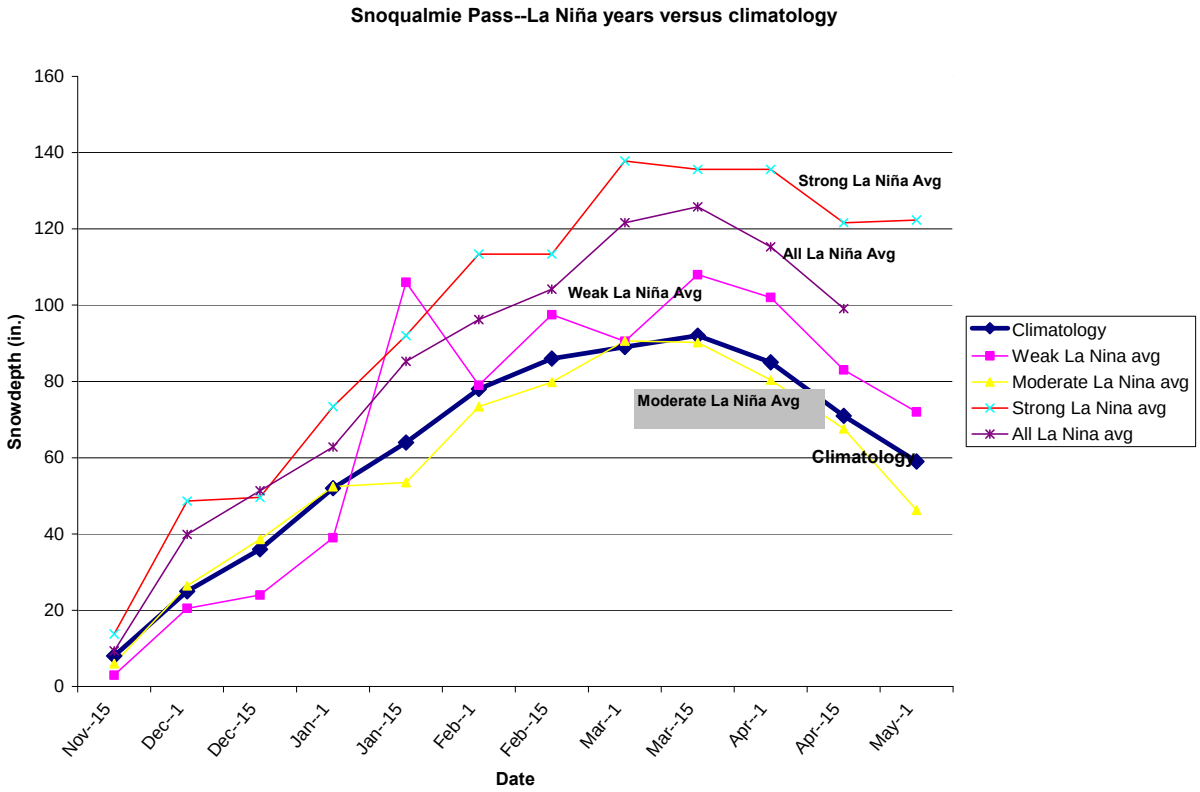


Figure 11. Crystal Mtn snowdepths vs climatology and La Niña years

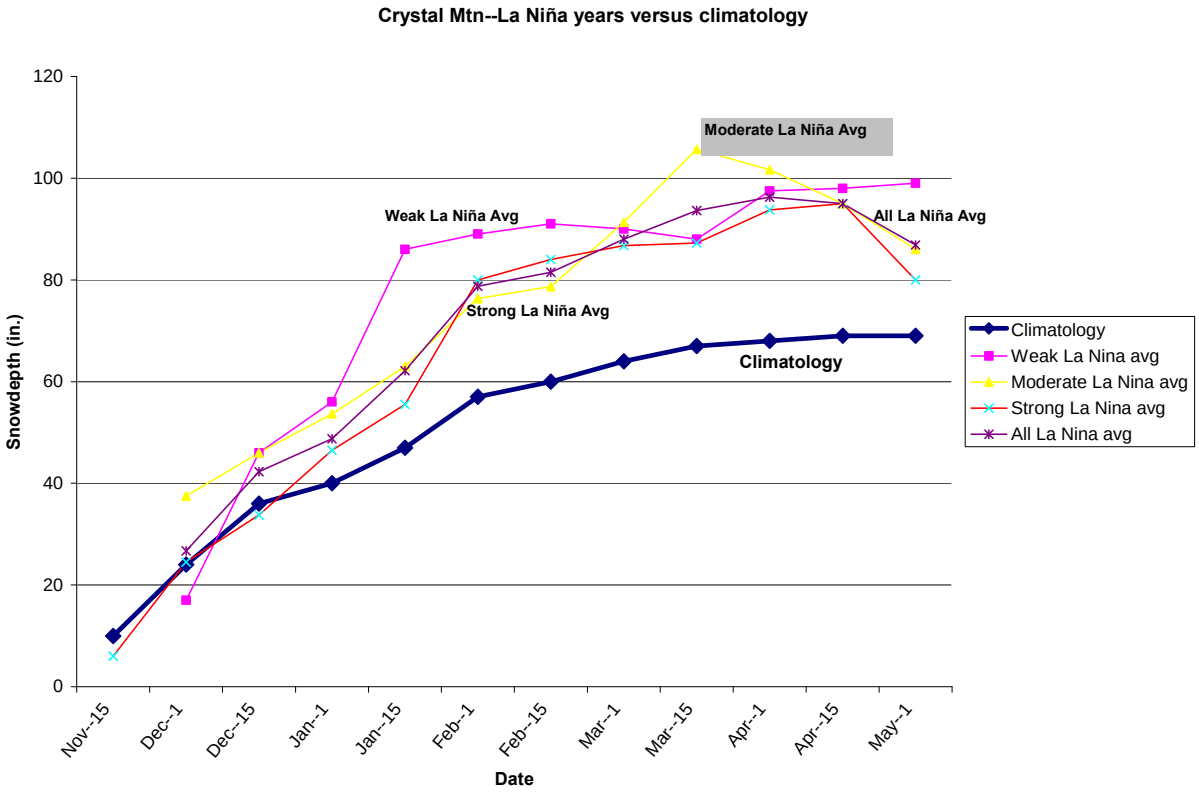


Figure 12. Paradise snowdepths vs climatology and La Niña years

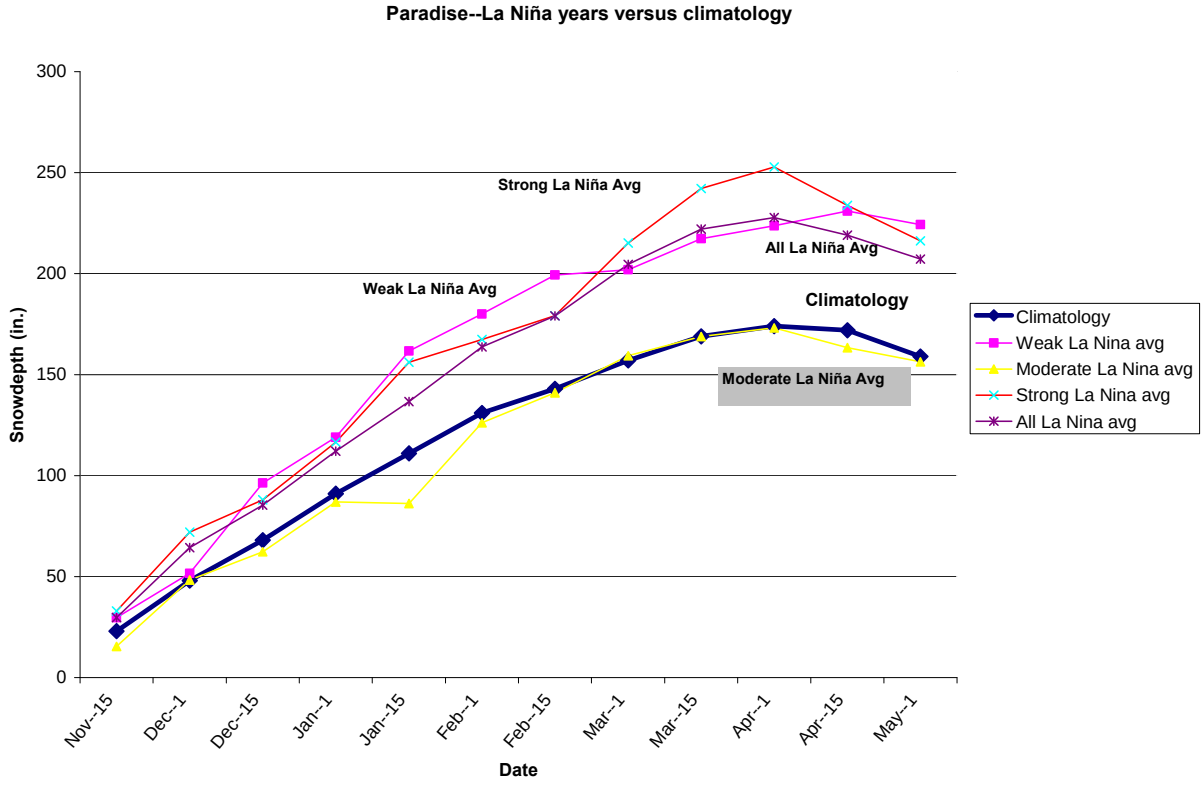


Figure 13. White Pass snowdepths vs climatology and La Niña years

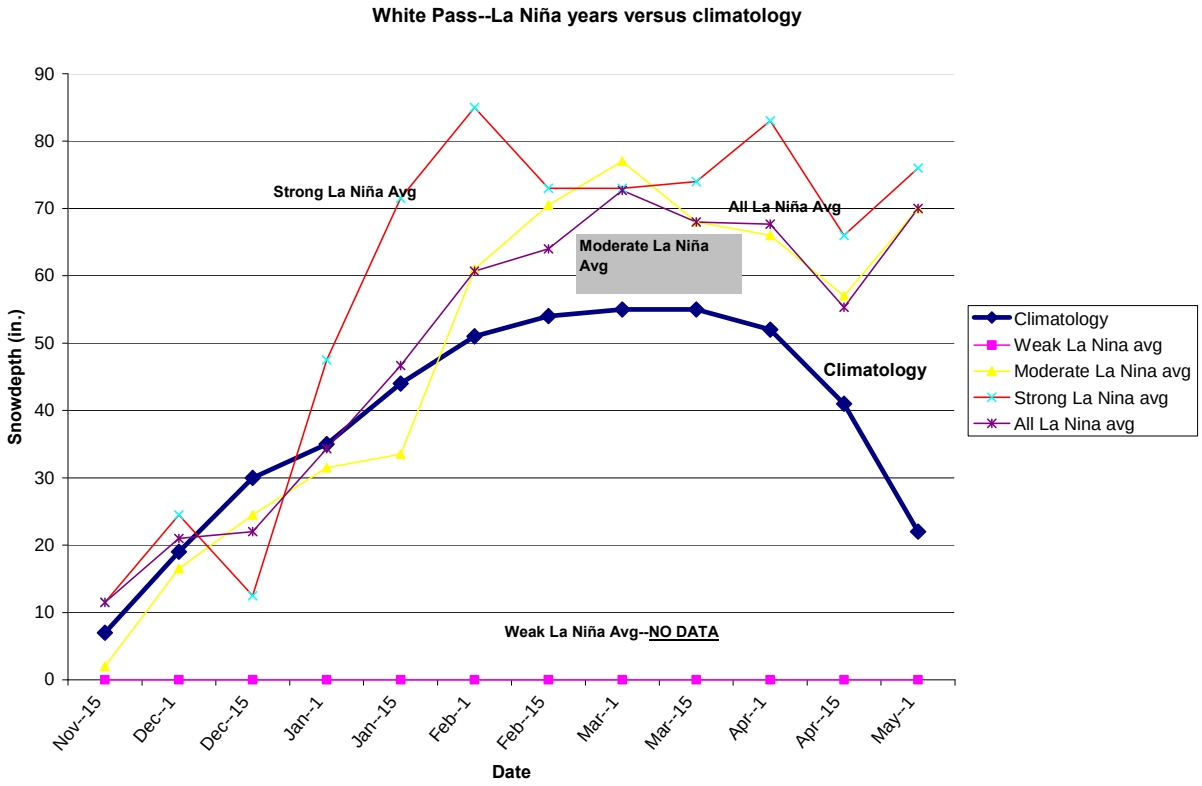
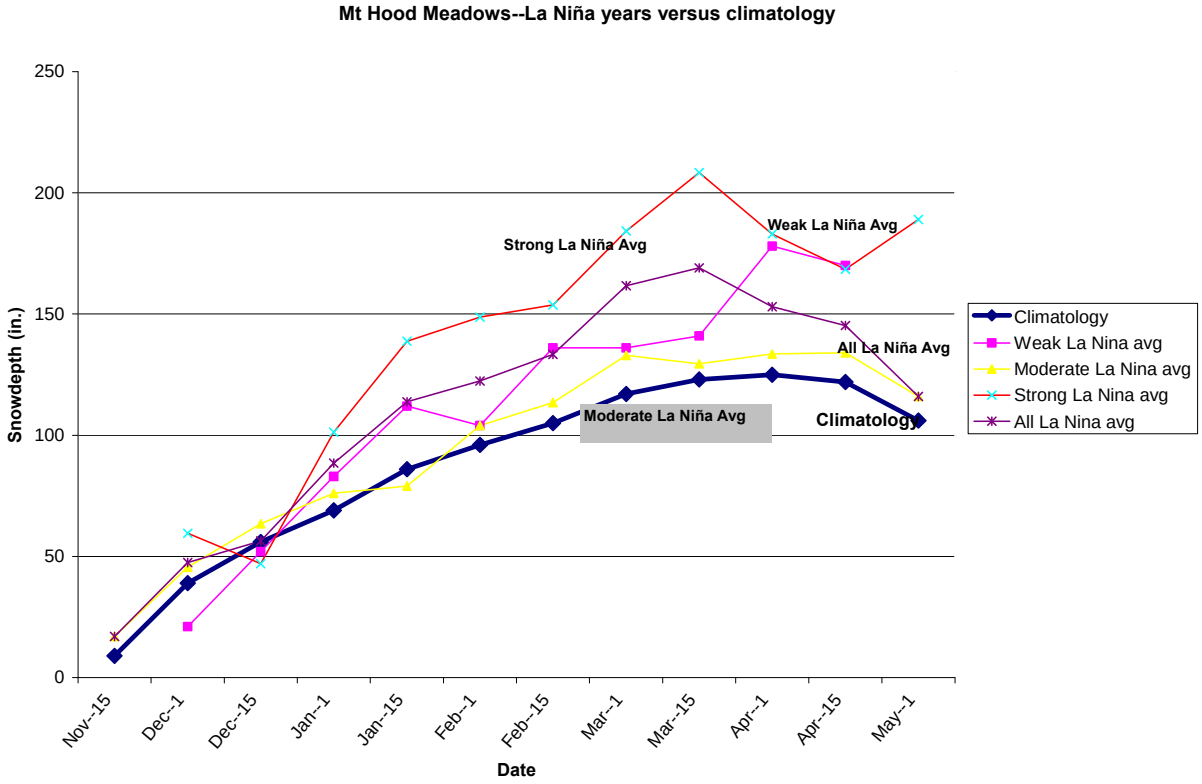


Figure 14. Mt Hood Meadows snowdepths vs climatology and La Niña years



Obviously the charts above indicate a potential for abundant snowfalls during most La Niña winters, and certainly the past La Niña winter was one of those.

The most recent La Niña discussion issued by NCEP indicates that the effects of this season's La Niña have pretty much waned or may even become Eñso-neutral over the summer. However, with the spread in forecasts (see below) about what next winter may bring (El Niño, La Niña or Neutral), it remains possible that a La Niña repeat is not out of the question.

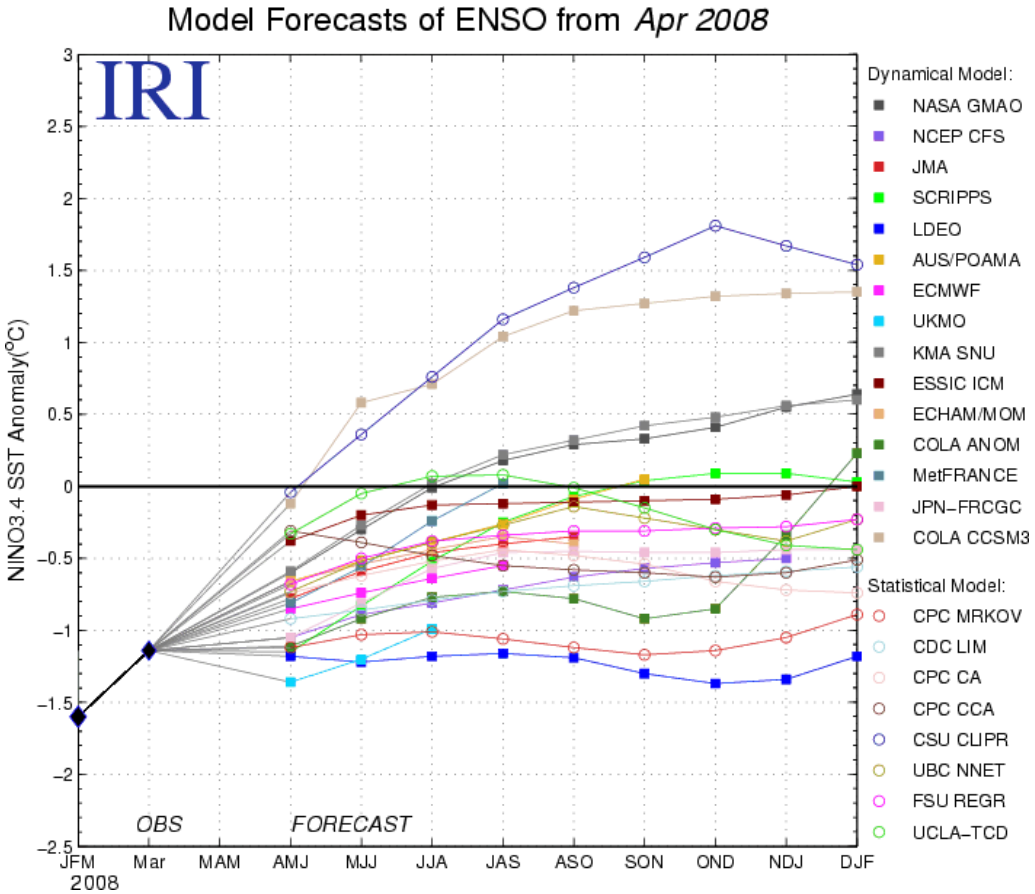


Figure 15 . Forecasts of sea surface temperature (SST) anomalies for the Niño 3.4 region (5°N-5°S, 120°W-170°W). Figure courtesy of the International Research Institute (IRI) for Climate and Society, updated 18 April 2008.

As is illustrated above, a majority of the recent dynamical and statistical SST forecasts for the Niño 3.4 region indicate La Niña (negative SST anomalies for Niño3.4 region) will persist through May-June-July 2008. Thereafter, there is considerable spread in the forecasts, with the majority reflecting ENSO-neutral conditions (-0.5 to 0.5 in the Niño-3.4 region) during the second half of the year. However, the spread of the models spans the possibility of a return to La Niña or even an El Niño by the end of 2008. Based on current atmospheric and oceanic conditions and recent trends, a transition from La Niña to ENSO-neutral conditions is possible during June- July 2008.

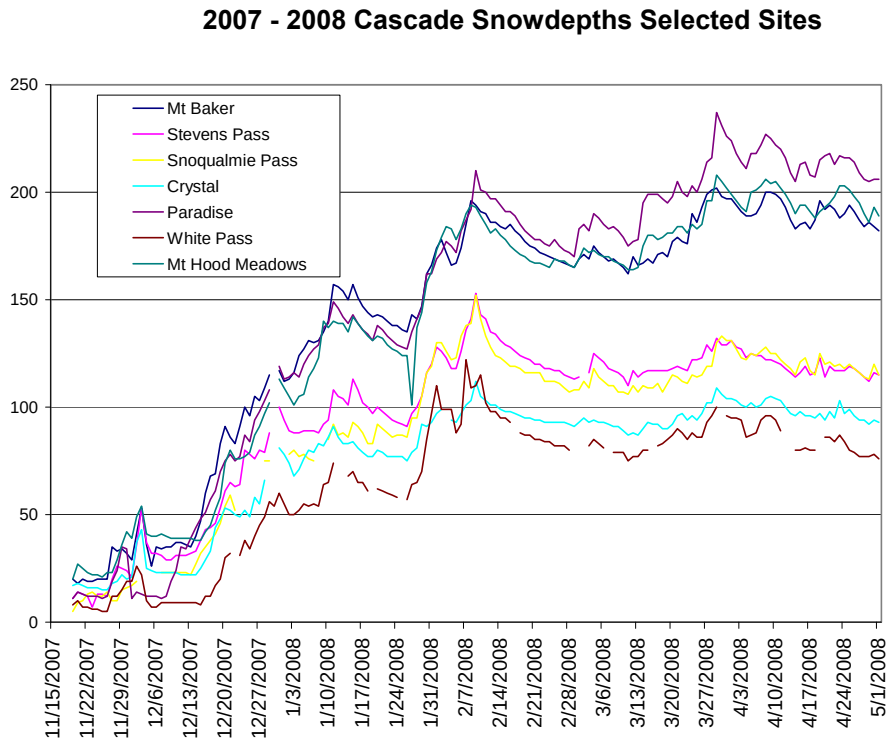


Table 2. 2007-08 Cascade snowdepth evolution, selected sites.

Our start to the La Nina winter occurred rapidly during a short but major storm and avalanche cycle in early December. The last storm in this cycle on 3 December was fueled by moisture from the remnants of Typhoons Hagibis and Mitag. Sites near the Cascade crest in the Washington Cascades received about 3 feet of snow in 2-days on 2 and 3 December. This came with major warming trend which changed the heavy snow to heavy rain on 3 December. The increasing wet snow and rain generally accumulated on crust layers over a shallow November snowpack. This cycle is indicated in the chart above by the spike in snow depths in early December. Five avalanche deaths in 2 accidents occurred in the Washington Cascades during this weather and avalanche cycle.

The next extended storm cycle was seen from mid December to mid January. Hurricane Ridge and sites near and west of the Cascade crest accumulated 17 to 24 feet of snow during this 1 month period. Many sites had several or more days, sometimes consecutive days, of a foot or more of snowfall. Snowfall was especially heavy at Mt Hood. Three more avalanche accidents, on 18 December, New Years Day, and 4 January, claimed the lives of 4 more people in the Washington Cascades.

Another extended storm cycle was seen the last few days of January through the first half of February. Sites near and west of the Cascade crest picked up about 10-15 feet of snowfall during this 2 week period. All 3 major Cascade pass highways (Stevens, Snoqualmie, White Passes) had extended simultaneous closures during this period. The most snowfall was seen at

Paradise and White Pass which averaged over a foot a day for 2 weeks! We often heard tired voices each morning during this period when talking to snow safety crews. The public was paying more attention to the avalanche forecasts (see chart below) and perhaps this is partly why there were no more avalanche deaths during this time. Either that or people were unable to get to the Cascades due to closed roads.

The Northwest experienced a very unusual cold spring with snow continuing to accumulate in April in the Olympics and Cascades. Total snow at Snoqualmie Pass in April was mostly deeper that total snow at Stevens Pass. Record total snow depths were recorded in the south Cascades at White Pass and Mt Hood Meadows by 1 May.

ACCIDENT SUMMARIES

The goal here is to give short descriptions for the fatal accidents that occurred in the Cascades this winter. We tried to present what seems relevant and also hope that readers might reach or have some of their own conclusions. More complete accident reports are available on the NWAC web site (www.nwac.us) and on the Westwide Avalanche Network web site (www.avalanche.org). A solo back country skier also went missing on 27 April on the west side of Mt Baker. This was during a period of significant avalanche danger, although the cause of the disappearance remains uncertain.

Union Creek, 1 or 2 December 2007

Most of this information is from a Seattle Times news article. Kevin Carter, 26, Devlin Williams, 29, and Phillip Hollins, 41 were apparently last seen descending into the Union Creek basin near Crystal Mountain ski area on 30 November or 1 December. They were traveling via snowshoes and snowboards. They have not been found and it is presumed they were caught during the widespread avalanche cycle that began on 1 and 2 December. A searcher commented that they might eventually be found in another nearby drainage if they were caught while trying to make their way back to the ski area.

*	Low temp (6870', deg F)	High temp (6870', deg F)	24 Hour Precipitation at 4 am (4480', WE inches)	24 Hour Snowfall at 4 am (4480', inches)	Total Snowdepth at 4 am, (4480', inches)	Wind at time of peak gust (6870', direction/average speed/gust, mph)
30 Nov	9	17	0	0	20	248/25/51
1 Dec	17	29	.02	0	21	247/36/70
2 Dec	30	38	.93	18	37	250/41/87
3 Dec	24	34	4.04	15	43	250/30/57
4 Dec	20	27	3.87	0	25	287/14/20

Table 3. Selected weather and snowpack data for Crystal Mountain, WA, for Nov 30-Dec 4, 2007.

Wind, warming and increasing heavy precipitation that changed snow to rain were the main causes for this widespread avalanche cycle. These weather trends are seen in the data from NWAC weather stations at the Crystal Mountain ski area (WE = water equivalent).

Source Lake, 2 December 2007

The following information is mainly from a report provided by Rob Gibson of the Alpental ski area. A party of 3 snow campers (husband and wife Mark and Stacia Thompson, 38 and 33 respectively, and friend Craig Stanton, 38) hiked to Snow Lake on Saturday 1 December. Late in the morning of Sunday 2 December the party broke camp and ascended back to the ridge between Snow Lake and Source Lake. From the accident report:

> "*The wind was strong at their backs and the ridgeline was scoured to the old snow and dirt. It was obvious that the steep slope before them was in the lee and significantly loaded but the very strong wind made staying on the more exposed ridgeline uncomfortable and they began to descend onto the loaded slope. The survivor was the most experienced of the group and was in the lead, hoping to trigger a sluff ahead of him and relieve some of the slope's avalanche potential. He stated that they began to descend in single file and reports hearing an exclamation from behind by one or both of the other party members just prior to being hit from behind by a wave of snow and carried down slope rapidly.*"

The survivor (Mark Thompson) was partly or completely buried with a broken leg but able to extricate himself. Rescuers found him in a partly erected tent on Tuesday morning 4 December. The 2 completely buried dead victims were found soon after using a rescue dog. Rob later commented that his impression was that the slab released and stayed in new snow layers.
Note this was the same weather and avalanche cycle as described above for the Union Creek accident. Again the warming trend and change to rain is obvious. Here is the NWAC Alpental 3120' base station data. The upper mountain data is not available.

Table 4. Selected weather and snow data from Alpental, WA, Nov 30-Dec 6, 2007.

✲	Low temp (deg F)	High temp (deg F)	24 Hour Precipitation at 4 am (water equivalent, inches)	24 Hour Snowfall at 4 am (inches)	Total Snowdepth at 4 am, (inches)
30 Nov	21	27	.04	0	17
1 Dec	17	21	0	0	20
2 Dec	18	30	1.16	19	34
3 Dec	30	43	2.91	10	45
4 Dec	35	43	3.69	0	34
5 Dec	30	37	.93	0	30
6 Dec	30	33	.06	0	28

Edith Creek, 18 December 2007

The information in this report is mainly from a news article in the Seattle Times. Troy Metcalf (age?) and Kirk Reiser (22) climbed partway to Camp Muir on Tuesday 18 December and turned around due to bad weather conditions. They apparently descended from the vicinity of Pan Point toward Edith Creek Basin. Reiser apparently triggered the avalanche that carried him into Edith Creek Basin, A rescuer commented that Reiser's body was in a moat between perennial snow and a cliff. The news report described the avalanche as 40 yards wide by 200 yards long. Metcalf searched for several hours before having to return to Paradise for help. After avalanche control was performed to protect the rescuers, searchers using metal detectors and search dogs located a deeply buried Reiser the following day.

Here is a table of data from NWAC weather stations at Paradise.

Table 5. Selected weather and snow data from Paradise, Mt Rainier, Dec 17-22, 2007.

✳	Low temp (deg F)	High temp (deg F)	24 Hour Precipitation at 4 am (water equivalent, inches)	24 Hour Snowfall at 4 am (inches)	Total Snowdepth at 4 am, (inches)	Wind at time of peak gust (direction/ average speed /gust, mph)
17 Dec	19	26	.2	9	57	266/8/25
18 Dec	25	31	.64	7	61	275/25/45
19 Dec	24	28	.67	13	70	273/21/37
20 Dec	16	25	1.04	10	75	275/5/17
21 Dec	17	25	.35	7	78	253/3/12
22 Dec	23	31	.02	0	75	276/6/24

Excelsior Pass, 1 January 2008

The following information is from a rescue report written by Mark Moore from information provided by Bellingham Mountain Rescue. A group of 5 snowmobilers was high marking in the vicinity of Excelsior Pass on New Years Day. At about 1 pm a slab was triggered on a 35-45 degree west facing slope at about 5400 feet. The slab was about 5-7 feet deep by about 100 yards wide. The avalanche caught all 5 but 2 were able to escape and 1 was only partly buried. The first victim was found by transceiver and excavated by the other 3 after about 2 hours. The second victim was not wearing a transceiver and was found by probes and excavated the next day by rescuers.

A warm spell was seen in the Cascades from about 22-24 December which formed crusts in many areas. There was about a foot of snow about every other day at the Mt Baker ski area in the second half December. An approaching front caused warmer temperatures and increasing southeast winds on 1 January at least at the ski area which may have contributed to the formation of wind slab on the fatal slope.

The following weather data is from the NWAC weather stations at the Mt Baker ski area. The wind instruments are unheated so rime effects are frequently possible. Rime effects stopped the wind instruments for most of the day on 31 December.

Table 6. Selected weather and snow data from Mt Baker, Dec 27-Jan 1, 2007-08.

✻	Low temp (5000, deg F)	High temp (5000, deg F)	24 Hour Precipitation at 4 am (4210', water equivalent, inches)	24 Hour Snowfall at 4 am (4210' inches)	Total Snowdepth at 4 am, (4210' inches)	Wind at time of peak gust (5000', direction/ average speed /gust, mph)
27 Dec	17	21	.13	5	103	189/23/31
28 Dec	21	25	.41	11	109	202/7/30
29 Dec	18	21	.93	15	115	175/16/23
30 Dec	18	23	.38	8	117	170/6/16
31 Dec	18	23	.27	1	117	Rimed
1 Jan	20	33	0	0	112	150/33/55 (evening)

Figure 16. View upslope from the deposition zone looking east. Photo courtesy Bellingham Mountain Rescue.

Lake 22, 4 January 2008

This information comes from a report written by Mark Moore, based on information from Everett Mountain Rescue, available on the NWAC web site. A group of 1 adult and 6 youths were descending the Lake 22 trail on foot during the midday or afternoon of 4 January. The group was crossing a N-NE facing gully at about 2200 feet when a natural avalanche from above hit 4 of the group, partly burying 1 youth and completely burying 3 of the youths. The partly buried youth was able to self-extricate and 2 of the others were quickly found by probing with ski poles. A buried girl could not be found. The group returned to a ranger station (likely Verlot) and called 911 at about 16:45 PST. Everett Mountain Rescue responded and found the victim by probing at about 21:30 PST, about 2-300 feet below where the group was struck on the trail.

The gully in which the group was struck apparently extends for several hundred feet above the trail. Everett Mountain Rescue reported blocks of snow of about 1.5 meters thick above the trail which may have been pieces of a cornice. The group also reported that they had turned around and were descending in part due to increasing rain.

Figure 17. Looking uphill from where the group was struck on the Lake 22 trail. Photo: Oyvind Henningsen

Data from NWAC weather stations at Stevens Pass seemed more relevant than data from NWS coop sites at Baring and Darrington, or data for a NRCS site at Alpine Meadows in the foothills east of Seattle.

Table 7. Selected weather data for Stevens Pass, January 2-5, 2008.

✻	Low temp (4000', deg F)	High temp (4000' deg F)	24 Hour Precipitation at 4 am (4000' water equivalent, inches)	24 Hour Snowfall at 4 am (4000' inches)	Total Snowdepth at 4 am, (4000' inches)	Wind at time of peak gust (4900', direction/ average speed /gust, mph)
2 Jan	18	23	.01	1	89	83/17/27
3 Jan	21	28	.16	2	88	51/17/23
4 Jan	26	32	.25	6	89	47/13/30
5 Jan	20	31	.39	6	89	240/13/29

There was 140" of snowfall at the Stevens Pass NWAC weather site in the second half December and the first 4 days of January. This should indicate that a lot of snow or cornice

buildups were available for an incident. The temperatures and the wind direction change at Stevens Pass indicate a warming trend.

NORTHWEST STATISTICS

An eyeball average shows about 2 avalanche deaths per season in Washington. Most of these accidents kill 1 person, with no more than 3 killed in a single accident in the last 30 years. This chart does not include the 11 deaths in an icefall accident on Mt Rainier in June 1981.

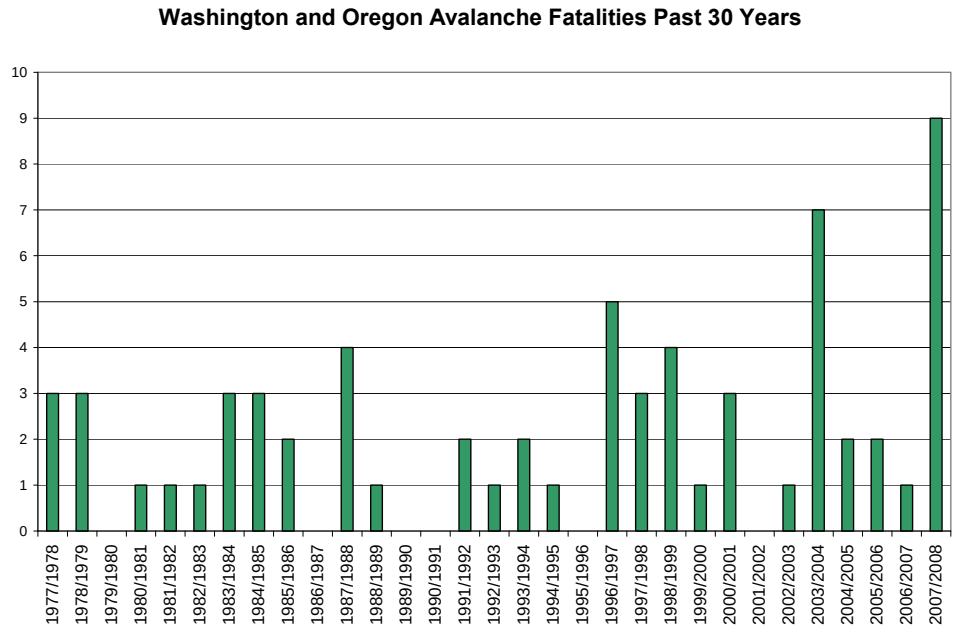


Figure 18. Annual NW avalanche fatalities by year, 1977-2008 (past 30 years)

The number of warnings issued for the season by the NWAC was above the usual for the past few seasons, but not above some seasons in the 1990's.

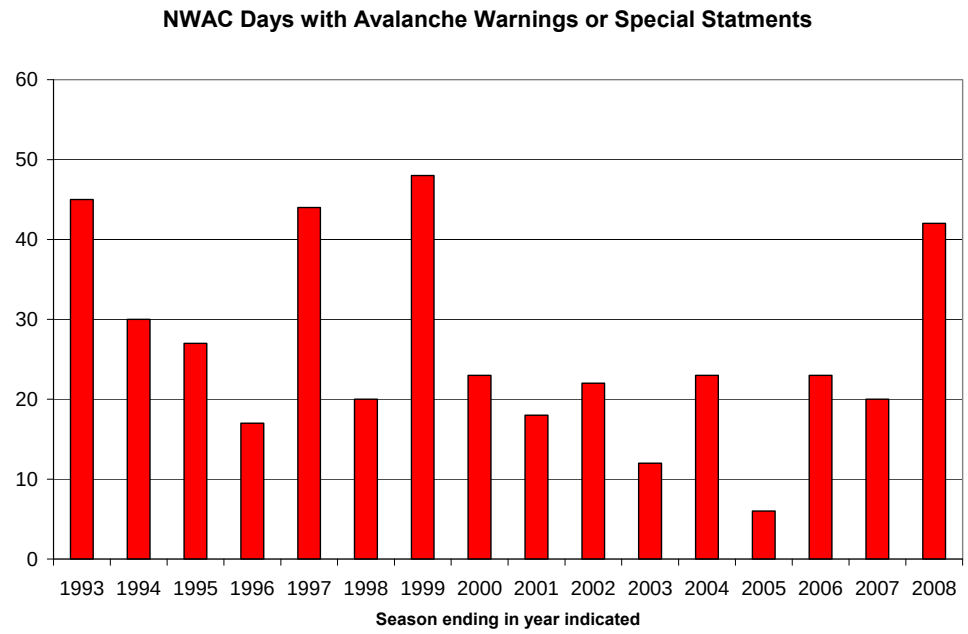


Figure 19. Days with avalanche warnings or special statements by year, 1993-2008.

The number of additional warnings came mainly in December, January, February and partly in May and June.

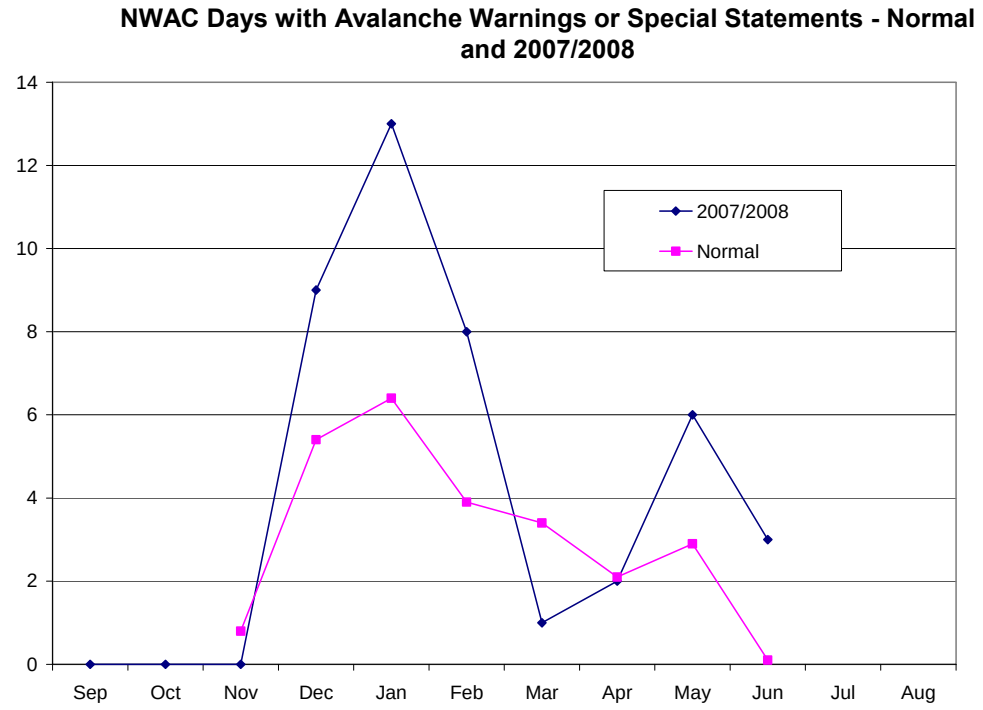


Figure 20. Number of days with avalanche warnings or special statements, normal versus 2007-08 winter.

Internet visits to the NWAC avalanche forecast normally peak in January and also peaked in January 2008.

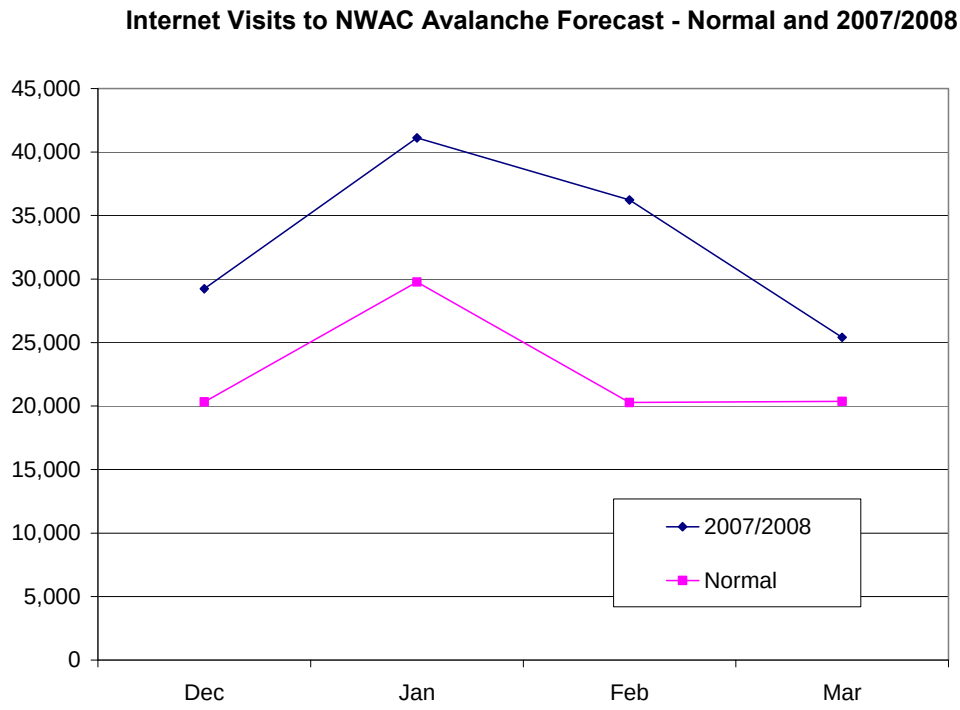


Figure 21. Web site access of avalanche forecast--normal versus 2007-08 winter.

SPECULATION REGARDING NORTHWEST FATALITIES THIS SEASON

The 2007/2008 season is unusual in Washington in that:

- This was a La Nina season with heavy snowfall in the Cascades and a lack of normal rain events.
- There were 9 fatalities compared to normal of about 2 per season.
- A major widespread avalanche cycle occurred early December.

Internet visits to the NWAC avalanche forecast (chart above) suggests that people are not paying as much attention to avalanche forecasts early in the season. Perhaps the major avalanche cycle in early December 2007 and less attention to avalanche forecasts early in the season were a factor in the fatalities this season.

It is interesting to note that the most avalanche deaths in the Northwest have occurred in December in recent years. This chart also does not include the 11 deaths in an icefall accident on Mt Rainier in June 1981.

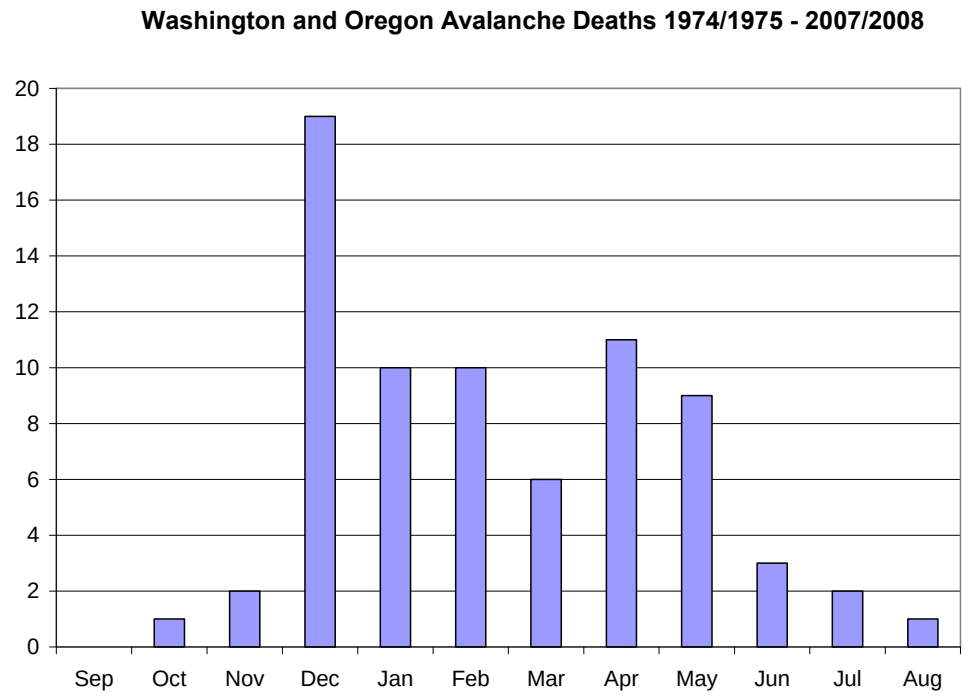


Figure 22. NW avalanche fatalities by month, 1974-2008.

STATISTICS

The United States had a record number of avalanche deaths (36) this season compared to recent years.

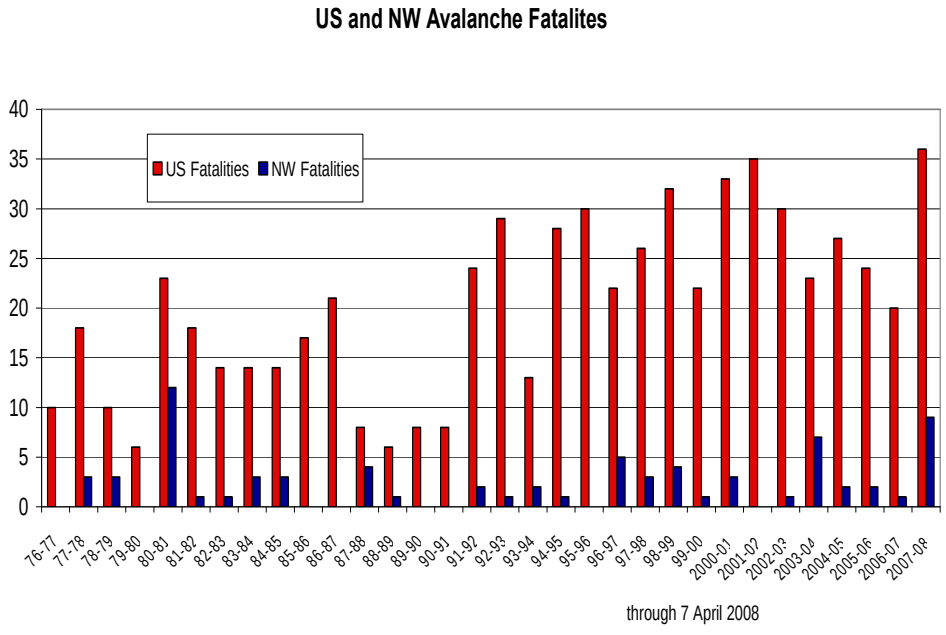


Figure 23. Comparison of annual US versus NW avalanche fatalities, 1976-2008.

Deaths by activity category in the US were similar to last year with snowmobilers leading the way.

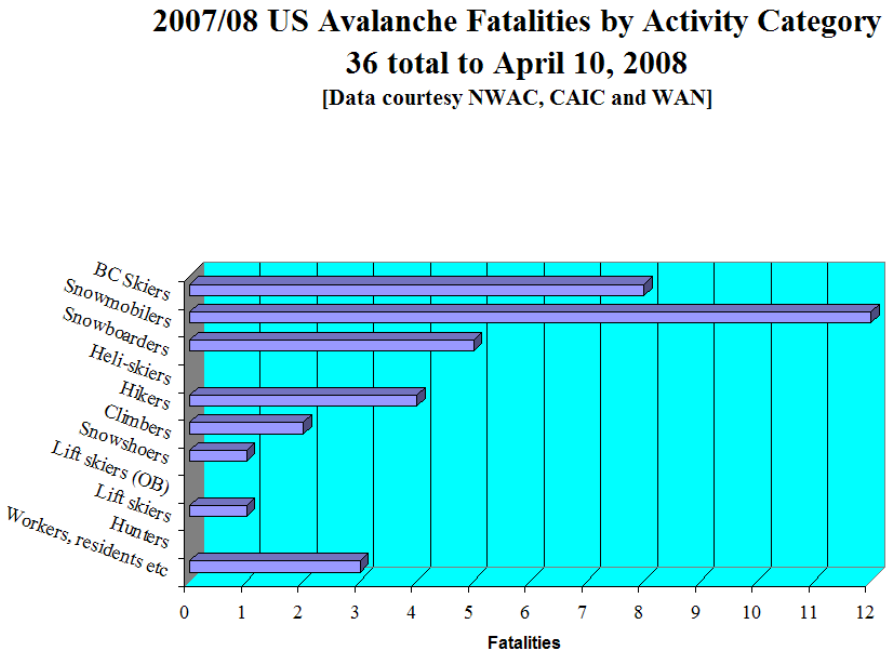


Figure 24. 2007-08 US avalanche fatalities by activity category.

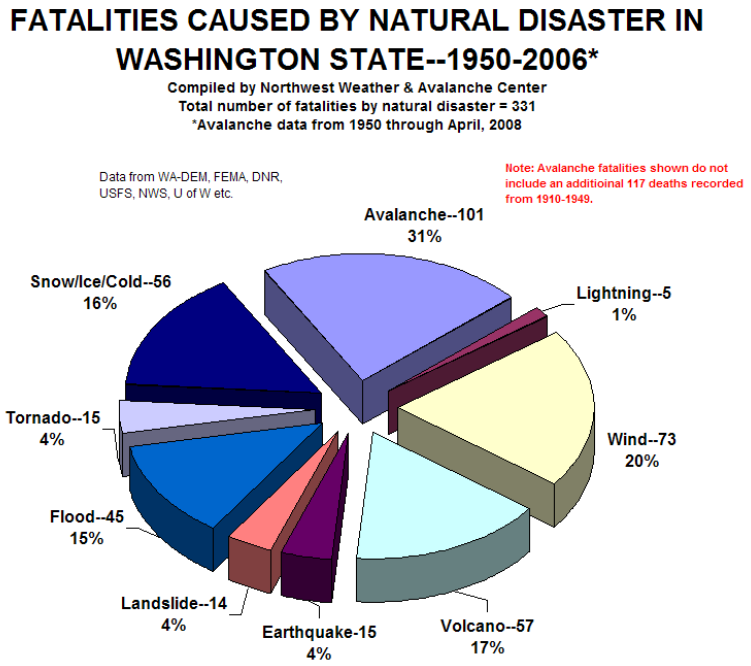
Washington had the most fatalities this season of any state in the US.

UNITED STATES AVALANCHE FATALITIES by STATE
1985/86 to 2007/08 (to April 10, 2008)

	Winter Season																						23 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	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	131	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	90	4.1	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	74	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	66	2.9	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	45	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	41	1.7	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	32	1.4	ID
CA	2	0	0	0	1	0	2	1	0	2	0	0	1	1	0	2	1	1	1	3	1		4	23	0.9	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	0.3	NH
OR	0	0	0	1	0	0	0	1	2	0	0	0	1	1	0	0	0	0	0	0	0			6	0.3	OR
NV	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	1	0			4	0.2	NV
NY	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0			2	0.1	NY
VT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0			1	0.0	VT
AZ	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0			1	0.0	AZ
ND	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0.0	ND
NM	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0			1	0.0	NM
TOTAL	17	21	11	6	8	8	24	29	13	28	30	22	26	32	22	33	35	30	23	27	25	20	36	526	22.9	TOTAL

Figure 25. Annual US avalanche fatalities by state, 1985-2008.

Avalanche fatalities continue to lead the way for deaths by natural disaster in Washington State.



A COUPLE PHOTOS

30’ of debris from a control avalanche across the highway at Tunnel Creek near Stevens Pass on 9 February 2008. Photo: Mike Stanford

Back country skier triggered slab avalanche in the Enchantments area of the central Cascades, victim seen standing in the debris on 24 April 2008. Photo: Anonymous

NORTHWEST AVALANCHE ACCIDENT TRENDS

Just like other areas of the country where weather events like floods, tornadoes, thunderstorms, ice storms and other natural events threaten human life, the Northwest US experiences its own life threatening natural phenomena every year. These phenomena include floods and wind storms, volcanoes and of course snow avalanches. In a year in which the United States set a modern era record (post 1950) of 36[1] avalanche fatalities, a La Niña dominated winter also produced a deep and relatively weak snowpack and a record setting 9 avalanche fatalities in Washington State (see Figures 18, 23 and 25). The accident onslaught really began just as winter was getting underway, with a very shallow snowpack and many slopes pretty devoid of snow just a week before the first fatalities of the season. In fact, the transition from hiking on bare or patchy snow trails to full on winter survival developed quickly on one fateful early December weekend.

While the recent and still slowly dwindling La Niña event resulted in an abundant snowfall winter throughout the region (Northwest snowdepths as of April 15, 2008, varied from about 100% to 190% of normal (average for all stations about 137%)), it also produced a relatively dangerous snowpack. The snowpack evolution during this ENSO winter in the Northwest included the following significant developments, all of which attributed directly to the rash of December-early January fatalities in the region:

- a very dramatic increase in snow depth early in the season (intense loading of a variety of weak layers),
- unusually persistent, low freezing levels (producing faceting and weakening of the snowpack near the early December crust),
- unusually deep, low elevation snowpack (avalanche danger at very low elevations)

Figure 26.US and NW avalanche fatalities--1976-2008 (through April 10, 2008)

The first five NW fatalities involved individuals who may have been prepared for a danger increase (in fact one group changed their destination because of the forecast), but perhaps not for the speed and magnitude of the increase that actually transpired over that early December weekend (December 1st-2nd). As can be seen from the Sunday Outlook on the NWAC Detailed Avalanche Forecast issued on Friday, November 30, 2007, the danger was forecast to ramp up dramatically, especially at lower elevations that prior to the weekend had only a very shallow snow cover:

SUNDAY AND SUNDAY NIGHT

[1] At the time of this writing, the thirty-six US avalanche fatalities include three snowboarders who disappeared in steep, mountainous terrain in the south-central Washington Cascades in a series of strong storms and high avalanche danger in early December. They remain missing and presumed killed by avalanches near Crystal Mountain, WA. Another skier's fate (not included in the 9 Washington State fatalities) remains unknown since his disappearance on Mt Baker in early May.

Moderate to heavy snowfall, increasingly strong winds and slow warming on Sunday should continue to load and stress a multitude of buried weak layers, especially on lee slopes above 4 to 5000 feet where most terrain and vegetative anchoring should be slowly buried. In such areas, a high danger is expected with natural and human triggered avalanches becoming increasingly likely Sunday afternoon. Initially, most slides may involve only the most recently received storm snow on Sunday, with fractures extending into the lower density snow received Saturday. However, instabilities should become quite sensitive and widespread, with shooting cracks, whomping, sympathetic and remotely triggered slides probable. With continued loading by heavy snowfall, very strong winds and further warming late Sunday and Sunday night, expected stresses should produce natural or human triggered slabs involving all of the recent snow down to the facets above the old early-mid November crust. This may produce fractures ranging up to 3 to 5 feet or more, with a high to extreme danger likely developing in terrain above about 4 to 5000 feet. As a result, back country travel is not recommended on steeper, avalanche terrain Sunday, and back country travel should be avoided late Sunday and Monday, with travel confined to relatively low angle terrain well away from avalanche path runouts.

A subsequent avalanche fatality on the 18th of December involved prolonged storm activity and potential deteriorating or white-out conditions on the slopes above Paradise on the southern slopes of Mt Rainer, while additional avalanche incidents in early January were direct results of either the unusually weak snowpack structure (snowmobilers triggering a large slide releasing on faceted snow near buried crusts) or the unusually deep snowpack at low elevations (hikers around the 2000-2500 ft level caught by a natural slide triggered by rain). To help stem the tide of avalanche accidents in the Northwest, a short summary of NW avalanche conditions and possible contributory accident factors was issued to the news media in early January. The text of this is included below:

Northwest Avalanche Conditions—January 2008

by Mark Moore

The evolution of the Northwest mountain snowpack this year has been remarkable and far from normal. After a very shallow snowpack in November, unusually large amounts of unconsolidated snow arrived very quickly and almost daily throughout December with this persistent pattern continuing relatively unabated into early January. Overall, snowfall ranged from about 150 to over 250 inches during a 40 day period—that's averaging over 6 inches/day every day for over a month. Combined with generally low freezing levels only infrequently interrupted by brief warming and rain episodes, this weather resulted in many avalanche accidents and several important factors that need to be considered by all back country travelers. These factors include:

- Our snowpack contains unusual characteristics that include deeply buried weak layers along with an associated potential of unusually large avalanches. Due to the nature of the deeply buried weak layers (some near the ground), this potential for unusually large avalanches may persist well into the spring. Future heavy rain events may help lessen but perhaps not eliminate the problem.
- We currently have an unusually deep snowpack at low elevations, and one whose stability may be strongly influenced by relatively small rises in freezing levels. Hence previous trips into "low risk" areas may present significantly increased danger this winter and spring. If on gentle terrain, be sure it's not connected to or lying below steeper slopes above that might provide larger avalanche releases.
- The need to be aware of the weather and weather trends before heading out on a trip, and continually updating or modifying your goals and expectations as a result of the weather. This awareness should expand into avalanche awareness if travel into snow covered terrain is expected. Consult web sites such as www.weather.gov/seattle or www.nwac.us for weather and avalanche forecast information.
- A hike or snowshoe in the mountains in winter is very different from the same hike in summer, though it may be viewed in the same way. Steep snow covered slopes present an objective

danger that increases the risk and always need to be considered, especially when travel takes one through or across such terrain. Be extra cautious around or avoid terrain traps like gullies or chutes where a relatively small amount of snow may result in a deep burial. Know that winds can increase the avalanche danger even if it's not snowing (wind transported snow onto lee slopes) as can rises in the air temperature (surface snow creeps downhill more easily when warm and either releases or stresses underling snow layers).

- Familiarity with an area can be both good and bad: good if it increases the awareness of potential avalanche problems, bad if previous good/safe experiences in the same area prevent or limit one's thoughts about potential risk (of avalanches)
- Stability within a more normal maritime snowpack typically swings back and forth between higher and lower danger levels, thus being a little more forgiving and allowing for some mistakes. The recent and current snowpack has not allowed for much deviation from generally considerable to high danger levels—this has not allowed much room for error, and there have been relatively few second chances offered.

After taking a brief breath in mid January, winter continued in earnest for much of later January through early-mid February. At this time a sustained strong storm track over the region produced one of the strongest westerly flows in recent history. When combined with a very weak underlying snowpack structure (that resulted from a previous period of cold weather, light winds and associated very weak snow layers), the heavy loading of weak layers produced a very large avalanche cycle and an almost simultaneous closure of all major Cascade highway corridors in the state as well as several in the Oregon Cascades and many in Idaho. Thankfully the NW avalanche fatality total did not experience an associated increase despite the substantial danger increase and many large avalanches (see photos below) and some property destruction. Perhaps this lack of more incidents was partly due to the lingering and painful memories about those lost earlier in the season. And hopefully it also partly resulted from mountain travelers listening, reading and heeding the multitude of avalanche forecasts and warning conditions. But unfortunately, the lack of more accidents probably stemmed from the fact that mountain access was very limited and for the most part denied.

Figure 27. Kahler Glen home near Lake Wenatchee, WA, destroyed by avalanche on February 7, 2008. Photo courtesy Mike Stanford.

Figure 28. Massive cornice fall in photo triggers large climax avalanche in White River Canyon near Mt Hood Meadows, OR on February 8, 2008. Photo courtesy Tighe Stoyanoff, Mt Hood Meadows Pro Patrol.

Although La Niña ensured that March continued relatively cool and stormy and this produced further avalanche activity that caught snowcats, skiers and snowboarders, the victims were lucky and none of the incidents proved fatal, at least in the Northwest. However, the continued strong storm activity produced four more avalanche fatalities in North America in March, with the accident locations ranging from Alaska to Quebec.

Although the NWAC normally ceases daily forecasting operation in mid-April, the reality of further moderate snowfall at low freezing levels into mid-late April of 2008 delayed this transition, with the Center finally ending daily operation on April 20th. However, a series of special statements continued throughout much of the following week due to a still only very slowly stabilizing snowpack. The continuing threat of a significant spring slide cycle involving the old early December faceted layers finally became a reality in mid-May as a prolonged (4 day) period of hot (13-15,000 ft freezing levels) descended on the region—the first such event since the previous summer/fall. Prior to this warming event, the deep NW spring snowpack could have evolved in two ways:

- If cool and showery weather persisted, the primary impacts of intermittent warming and sunshine would be primarily confined to near surface layers as instability and melt slowly works their way deeper into a slowly stabilizing and settling snowpack.
- However, prolonged and sudden warming could produce a rather large avalanche cycle that might involve most or all of this winter's snowpack down to the depth hoar and weak faceted layers that developed and became increasingly pronounced during the early part of last season (near the early December crust).

As a result of these two very distinct possibilities with significantly different outcomes, NWAC forecasters continued to monitor the weather and avalanche conditions and issued a variety of special statements in early May. These statements finally culminated in a series of warnings for generally high avalanche danger associated with the mid-May heat wave, the resulting melt water percolation, and the associated weakening of the snowpack in depth. This heat wave verified the second method of snowpack evolution described above. While limited field verification of the serious avalanches described in the statements was forthcoming from folks who chose to remain in more gentle terrain, some rather dramatic avalanches did occur during this period (see photos below)—though most of the larger releases were confined to the Northern Washington Cascades and the southern BC Coast Range. Perhaps re-visitation of a "close to the end of season poem" from the Avalanche Center is appropriate here...

> *While the forecast season is ending soon, snow should last well into June.*
> *We'll all be watching storms in spring, and unusual dangers they may bring.*
> *Though in the mountains your thoughts may stray, don't let them go too far away.*
> *For know you're on an unstable matrix, where gravity and weather meet to play tricks.*
> *Even those most savvy in winter travel, are fooled by melt as layers unravel.*
> *Watch out for warming or a strong spring storm, anything that changes what's the norm.*
> *For though old snow may bond well to new, sun and warmth turn it all to goo.*
> *And it may just be a little slide, but with terrain it becomes a dangerous ride.*
> *So keep checking snow all around, until finally it's run into the ground.*
> *--Mark Moore*

2007-08 FORECASTING OPERATIONS

To kick the winter season off, the Friends of the Northwest Weather and Avalanche Center (FOAC) hosted a number of snow related events last fall to promote avalanche safety and raise awareness. The Alpine Safety Awareness Program (ASAP) in cooperation with FOAC launched the first annual Northwest Snow and Avalanche Summit (NSAS) that took place November 17th in Seattle.

Speakers Included:

Mark Moore, Charlie Rubin, John Stimberis, Chris Brixey, Gary Brill, Craig Wilbour, Steve Christie, Larry Goldie, Patty Morrison, Sky Sjue, Margaret Wheeler, Steve Conger and Colin Zacharus.

Figure 29. NSAS circular for 2007 event.

The event was a great success with over 250 in attendance. NSAS was designed to reach a wide audience including ski patrollers, avalanche forecasters, WSDOT and county road maintenance personnel, ski guides, search and rescue teams, avalanche instructors, undergraduate and graduate students in snow science programs, applied researchers, outdoor leaders, and advanced recreationalists. The atmosphere was interactive, with presentations followed by an open panel discussion. Plans are underway for the second NSAS next fall to be held in Seattle November 8th, 2008.

The daily forecasting season began on November 27th, 2007 with twice daily mountain weather forecasts and avalanche forecasts. The combination of big snow winter snowfall in the northwest and record avalanche fatalities in Washington lead to a long and taxing forecasting season. With nine avalanche fatalities occurring over a period of one month and numerous and extended pass closures, there was intense media interest and there was a great deal of coverage

and exposure for the avalanche center and the products and services we provide. The chart below shows just how busy the forecasters were with all the attention.

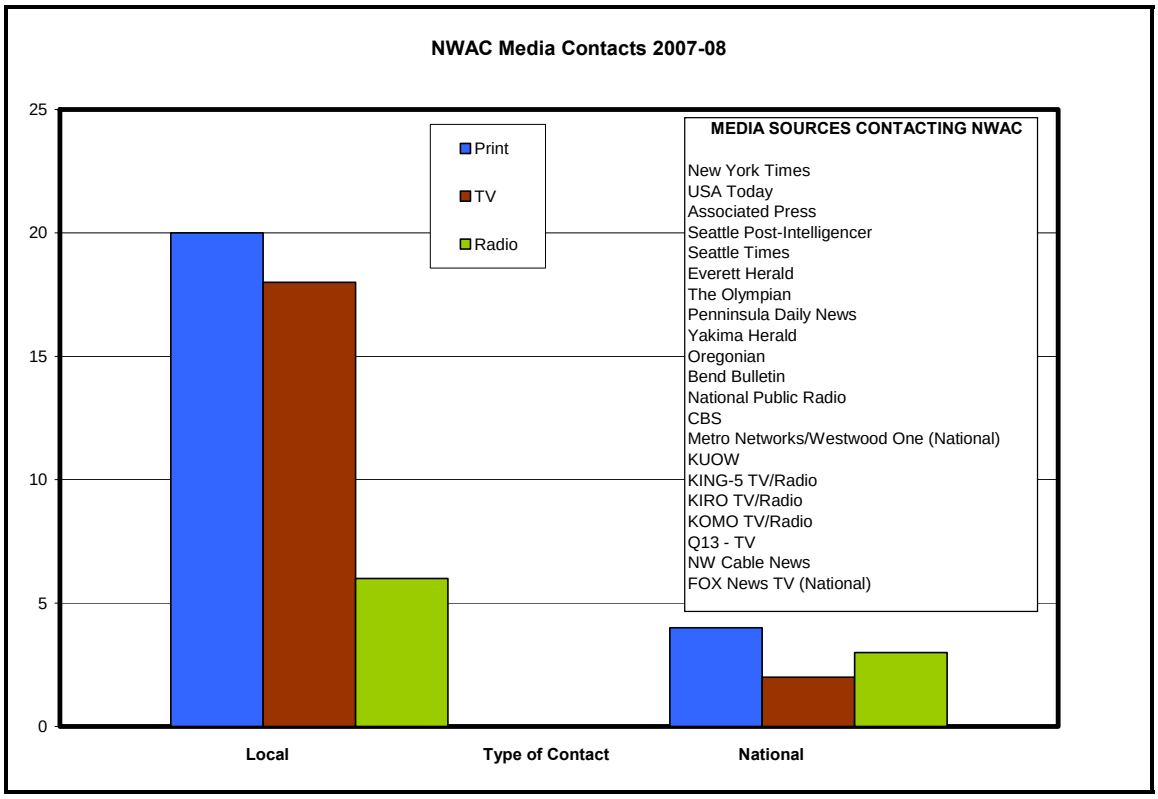


Figure 30. Media exposure during the 2007-08 season, a very busy year!

Normal daily forecasting continued until April 20th when the last regular forecasts were issued. However we were by no means done with the forecasting season. Many special statements were issued through the fall, including our final special statement issued on June 10th after receiving 3 feet of new snow in early June at Paradise that included 8 inches on Snoqualmie Pass on June 10th!

The NWAC forecasters make periodic trips to the back country assess snow conditions but those efforts must be supplemented to insure accurate and meaningful forecasts. NWAC relies on regular field observations from a variety of users and locations to help achieve this. The Friends of the Northwest Avalanche Center began an information exchange forum during the 2006-07 season that proved to be very successful. It was again a success this season with nearly 90 snowpack observations posted. NWAC also has pages on the web site to post relevant photos as well as snow pit profiles dug in the field. The chart below shows the steady interest in making these important sources of data available.

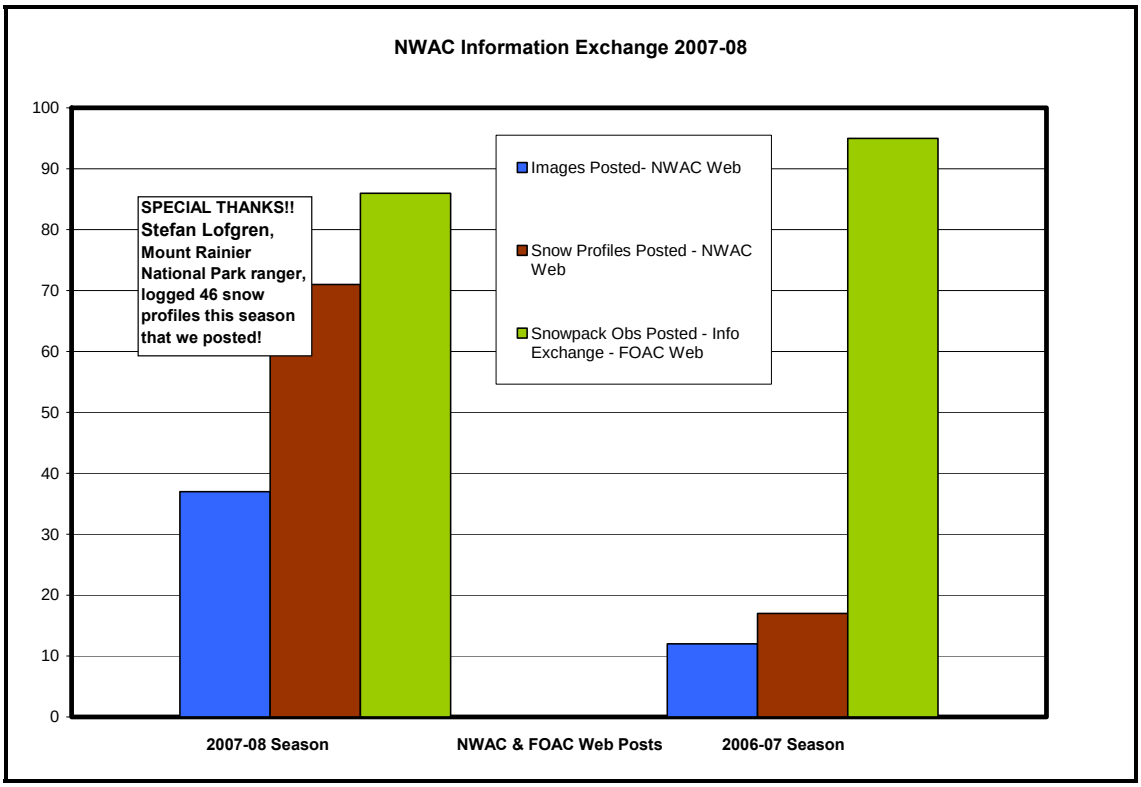
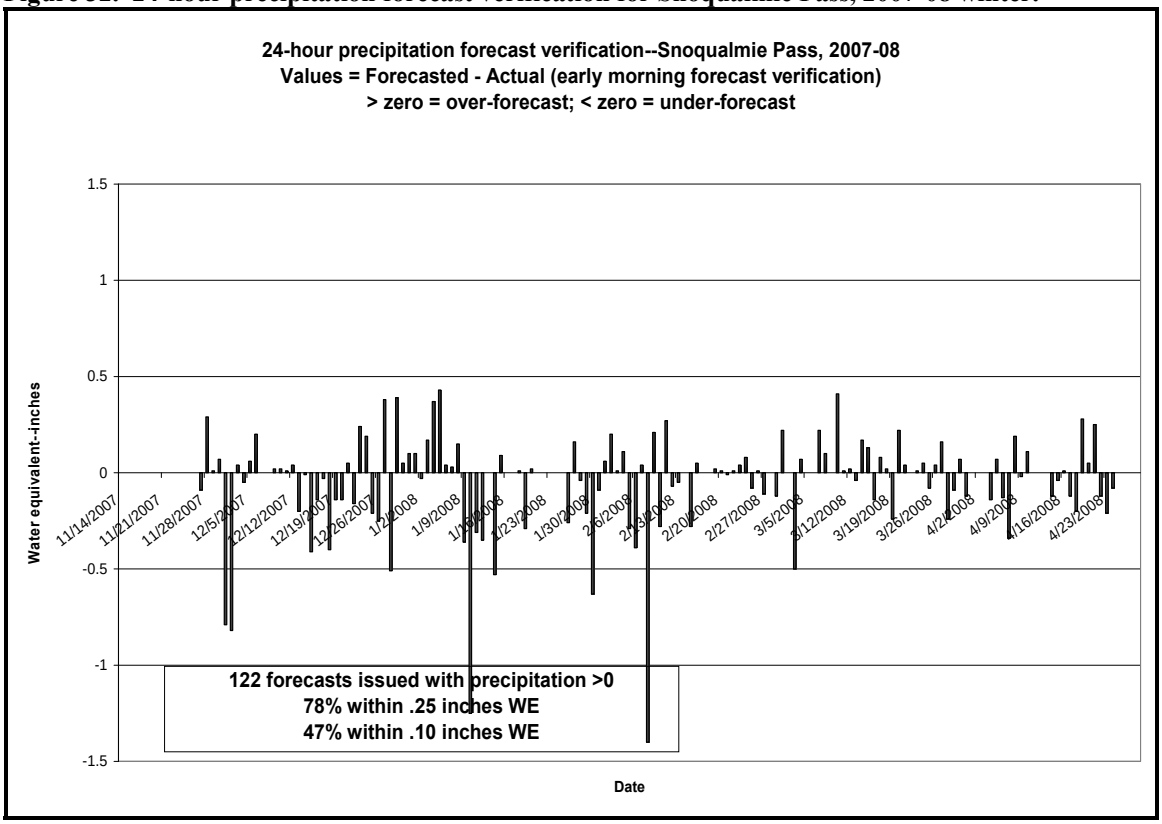


Figure 31. NWAC and FOAC making specific snowpack data available.

Figure 32. 24-hour precipitation forecast verification for Snoqualmie Pass, 2007-08 winter.



EDUCATION

The NWAC staff and retired Forest Service volunteers and FOAC board members Roland Emetaz and Ken White provide avalanche awareness presentations upon request. The table below presents a summary of presentations by both NWAC staff and FOAC volunteers for the 2007-2008 season, with these informational sessions reaching over 1300 persons.

Table 8. 2007-2008 Avalanche Education efforts by NWAC staff and volunteers.

2007-08 NWAC Avalanche Education Efforts

DATE	GROUP	LOCATION	ATTENDANCE	SPEAKER
10-Nov	Oregon Mountain Community	Portland, OR	50	Emetaz
17-Nov	Northwest Snow & Avalanche Summit	Seattle, WA	275	Moore
4-Dec	Oregon Nordic Club	Portland, OR	40	Emetaz
14-Dec	NPS - Olympics	Port Angeles, WA	20	Ferber
5-Jan	Holden Village	Chelan, WA	50	Emetaz
12-Jan	White River, REI Event	Mt Hood, OR	75	Emetaz
13-Jan	Northwest Avalanche Institute	Crystal Mtn, WA	35	Moore
15-Jan	Olympia Mountaineers	Olympia, WA	50	Emetaz
20-Jan	Northwest Avalanche Institute	Crystal Mtn, WA	35	Kramer
27-Jan	Northwest Avalanche Institute	Crystal Mtn, WA	26	Moore
29-Jan	Hillsboro REI	Hillsboro, OR	45	Emetaz
4-Feb	Nathan Hale H.S.	Seattle, WA	100	Moore
5-Feb	Mt Hood NF Staff	Sandy, OR	15	Emetaz
5-Feb	Tualitin REI	Tualitin, OR	40	Emetaz
6-Feb	Tacoma Mountaineers	Tacoma, WA	50	Emetaz
12-Feb	Vista School	Seattle, WA	15	Ferber
21-Feb	Hood River Coffeehouse	Hood River, OR	30	Emetaz
22-Feb	USFS - Wenatchee	Wenatchee, WA	36	Ferber
24-Feb	Thurston Co. ESD	Olympia, WA	15	Emetaz
6-Mar	Mountain Shop Ski Club	Portland, OR	20	Emetaz
17-Apr	UW - Hydrology class	Seattle, WA	20	Moore
7-May	Tacoma Mountaineers	Tacoma, WA	50	Emetaz
	Seattle Mountaineers - Snowshoe class	Bremerton, WA	25	White
	Seattle Mountaineers - Bremerton branch	Bremerton, WA	60	White
	West Seattle Explorer Middle School	Seattle, WA	90	White
	Everett Mountaineers - Cross Country Class	Everett, WA	25	White
	Everett Mountaineers - Basic Climbing Class	Everett, WA	40	White
	Issaquah Snowmobile group	Issaquah, WA	30	White
		Total…	**1362**	

During the past 12 years these outreach efforts have reached over 22,000 people.

Table 9. NWAC Avalanche Education Efforts by year, 1997-2008.

Year	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Persons	1178	1820	2440	1800	1800	2600	1486	1657	2858	1396	1868	1362
TOTAL	**22,265**											

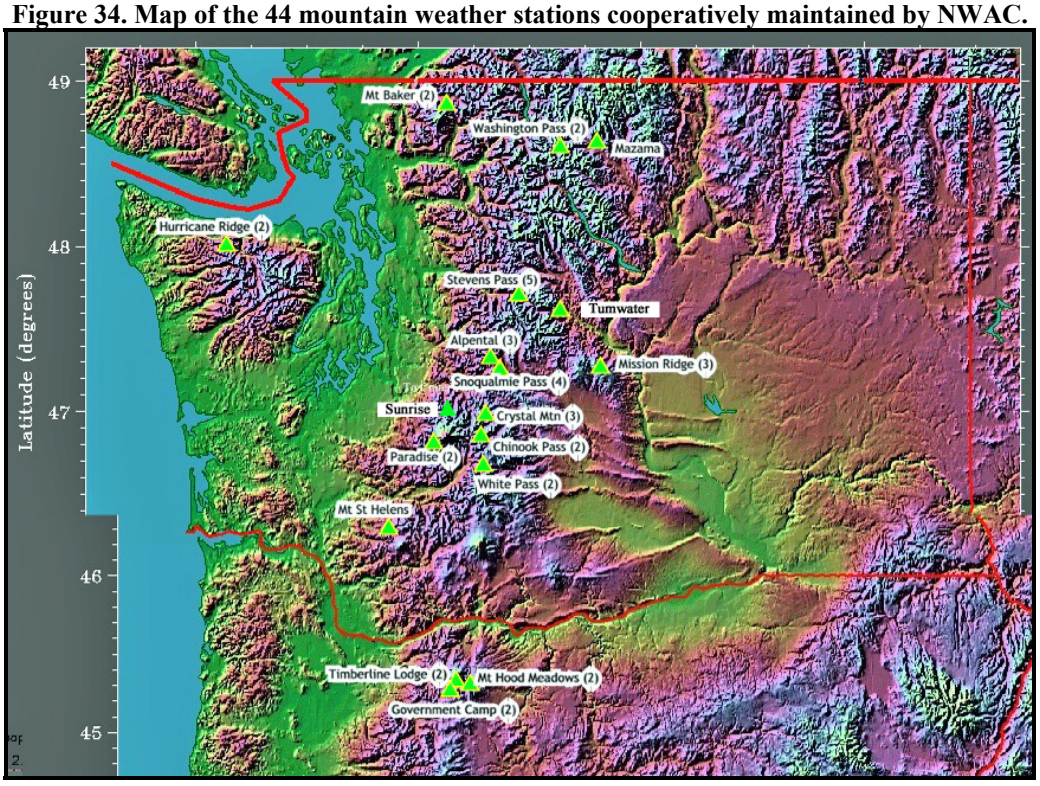
WEATHER STATION NETWORK

Mt Rainier–Camp Muir – http://nwac.us/products/OSOMUR
The NWAC in collaboration with Mount Rainier National Park installed this weather station in September 2006 at Camp Muir, 10,100 ft. The station provided reliable hourly data via a radio link to Paradise. Without the option for heat to de-rime wind sensors, the wind data is periodically unavailable. The wind vane suffered a catastrophic failure in mid-winter being completely sheared off, likely during a heavy rime event. We are looking to replace this with a more robust instrument for next season.

Figure 33. Garth atop the Camp Muir weather station sans wind vane.

Washington Pass – http://nwac.us/products/OSOWP9
After unreliable communications with the Washington Pass stations in 2006-07, repairs were made to the repeater atop Delancy Ridge in the fall of 2007. The communication link with this station in 2007-08 was remarkably reliable.

Figure 34. Map of the 44 mountain weather stations cooperatively maintained by NWAC.



FUTURE WEATHER STATION PLANS

Paradise, Mt Rainier – Due to planned demolition of the venerable Johnson Visitor Center (JVC) at Paradise, current location of the wind system, a new station will be erected near the old JVC in the middle divider of the ski dorm parking lot this summer. This new installation will include a new 30 ft Rohn 45G tower, heated wind speed and direction, temperature and relative humidity sensors, as well as data logger, phone modem, and charging regulator. Two way communications to station via either phone line or RF link to base station (planned summer 2008).

Precipitation Gage Development – Collaborate with Phil Taylor of Taylor Scientific on developing a new all season precipitation gage with versions for either electric or propane heat. Presently there are no commercially available propane heated precipitation gages, while the electrically heated gages currently used have become increasingly expensive to both purchase and maintain. They have also been very susceptible to the at times intermittent power surges common at remote sites adjacent to ski areas.

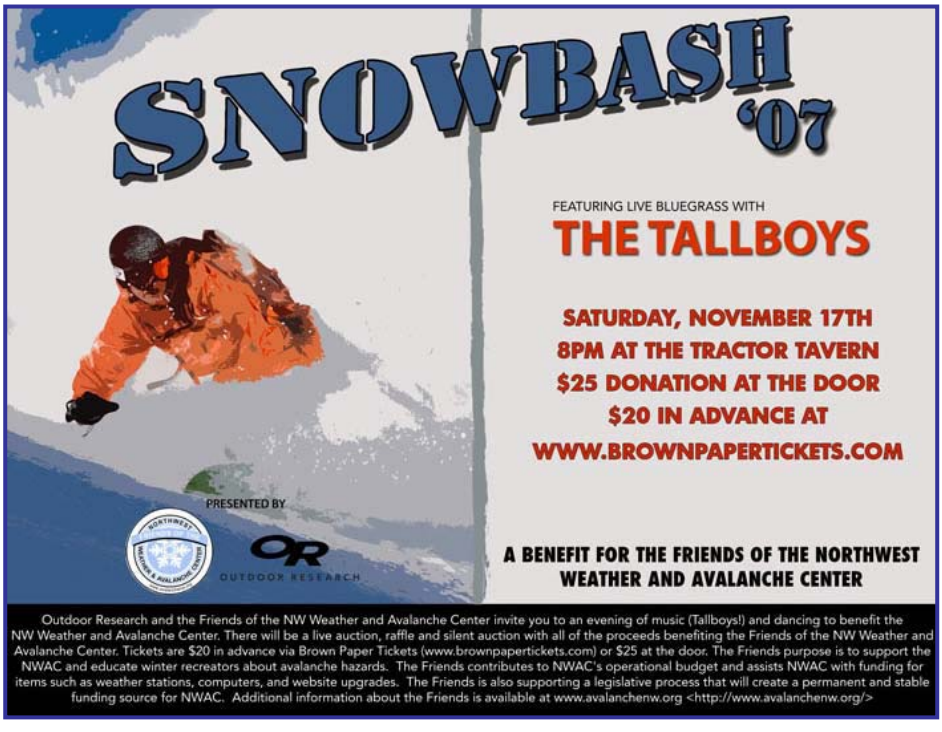
Hurricane Ridge tower relocation – For many years the precipitation and snow fall data from Hurricane Ridge have been strongly affected by winds, resulting in substantial drift formation under the total depth sensor, as well as decreased precipitation measurements in the heated precipitation gage due to turbulence and blowover. In order to reduce or eliminate such inconsistencies at this important site in the Olympic National Park, NWAC in collaboration with Olympic National Park, hope to relocate the precipitation and snowfall/snowdepth

measurements to a new and more protected location about 100 yards to the west of the generator building.

FUTURE POSSIBLE ADMINISTRATIVE CHANGE

A bill initially sponsored by Washington State Senator Ken Jacobson, Substitute Senate Bill 5219, was passed unanimously by both houses of the legislature and signed into law by Governor Christine Gregoire on April 20, 2007. As evident from the wording of the bill, the measure itself will not solve the perennial funding dilemmas that the Avalanche Center faces on an annual basis. However, it does stress the importance of the Avalanche Center to Washington State, its economy and the safety of its residents and visitors, and it provides the mechanism and funding for serious dialogue amongst all of its cooperators—federal, state, county, and private—dialogue that is intended to ensure stable long term operation and funding. While it is unclear whether or not this will result in a change of program administration from the federal to the state level, what is clear is strong state support of the Center's existence, both now and well into the future. A series of meetings planned for the next 6 months should provide the necessary direction and framework for any future changes in administration, operations or funding that will maintain a secure and effective program, with final recommendations on future operation and funding of the Center due to be delivered to the Washington State Legislature in December of 2008.

FRIENDS OF THE AVALANCHE CENTER



The Friends of the Northwest Weather and Avalanche Center (FOAC), an increasingly effective and important NWAC cooperator, promoted the popular SNOWBASH function and fundraiser to kick off the snow season. The 2007 edition proved to be another fun and grand event, helping to raise funds and awareness for the NWAC. SNOWBASH 2007 was held November 17th at the Tractor Tavern in the heart of Ballard and included a professionally called live auction, silent auction, gear raffles, great Blue Grass music, camaraderie and much more. While it was a great

success, FOAC is planning for an even higher profile sit-down catered dinner/auction/presentation for next year, details yet to be announced.

The Feathered Friends, an outdoor climbing and backcountry oriented retailer in Seattle, also sponsored a fund raiser for the NWAC on November 7th.

A slide show was the highlight of the evening with many equipment manufacturer representatives on hand to provide first hand information about their products. Lowell Skoog also presented a later talk at Feathered Friends (and Marmot Mountain Works) entitled "*Skiing the Cascade Crest: A Twenty-Five Year Journey across Time and Terrain*". The proceeds of this great presentation were donated to FOAC to help support NWAC operations.

NWAC BUDGET AND FUNDING

Annual financial challenges have become an increasingly common theme for continued viable operation of the NWAC, as evidenced by introduction of Substitute Senate Bill 5219 in 2007 (SSB-5219—discussed in last year's annual report and above in Future Possible Administrative Change) and the need for stopgap funding to prevent a significant reduction in NWAC program services this year. Thankfully, with the strong commitment of Washington State via the 2008 Supplemental Biennium Budget, looming large shortfalls in the operating budget were plugged for both the current (FY08) and next (FY09) fiscal years. Such important legislative action and funding support by the state has extended the Forest Service reorganization deadline and potential closure of the Avalanche Center until FY10, and given time for all of the impacts and ramifications of the meetings and recommendations provided by SSB5219 to manifest.

However, it is believed that the dialogue, recommendations and plan resulting from the bill will 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).

Returning to the present and the anticipated budgets for both this and next fiscal year [Federal fiscal years include October-December of the previous year and January-September of the indicated year—e.g., FY 07 runs from October of 2006 through September of 2007), please note that these projections were developed with the additional following assumptions:

- Small amounts of carryover funds are anticipated from FY08 to FY09, and FY09 to FY10
- Flat support levels are expected to continue from most cooperators, including the Forest Service and the National Park Service for the foreseeable future.
- In FY07, NWAC received $31,562 from Title II/RAC programs (North MBS, South MBS and Kittitas). Due to limited and late RAC program funding in FY08, only $8,000 in RAC monies is anticipated for FY08 and none in FY09 (the Title II/RAC program does not appear to have been reenacted by the federal government at the time of this writing). Such a drop in previously important program contributions played a significant part in NWAC's need for monies provided by the State Supplemental Budget.
- Unemployment and Medical expenses of approximately $14,000 in previous years are expected to drop to around $4,700 for the next two fiscal years (two of the forecasters are expected to have year-round funding through several fire or fire research related programs).
- Salaries are projected to increase at approximately +3%/year.
- While FOAC's direct contribution toward NWAC operation is expected to remain at $5,000, it is committed to sharing the cost of web site development for the NWAC's new web site. This expense may reach $20-30,000, to be shared by NWAC and FOAC.
- No matter what the final level of program funding turns out to be, all normal forecast and data services will be provided for as long as funding allows (this "all or nothing" program operation has been previously agreed upon with cooperators as the best way to meet future monetary shortages)
- Capital equipment expenditures averaging $20,000/year are projected at $25,000 for FY08 and $30,000 for FY09, which should help NWAC replace or repair some of its aging instrumentation in the field data network, as well as install several replacement stations (e.g., Paradise on Mt Rainier and relocated Hurricane Ridge site in the Olympic National Park). Note that with a projected average life span of 8-10 year/sensor and field capital equipment reaching upwards of ~$300-400,000, a conservative 10% replacement rate equals $30-40,000/year for the field data network alone.

As always it should be noted that the NWAC exists not only because of the direct funding by its many strong cooperators, but also through the many indirect and very important in-kind contributions that help to more completely reflect the overall value of the program. As shown below, these indirect monies are approaching $200,000 annually, and result in a program that provides substantially more benefits to each cooperator than its individual contributions might otherwise suggest.

Table 10. Sources of Funding for FY08 and FY09; Total direct and indirect funding.

NWAC Budget—Sources of Funding

Funding Source	[Direct Support]	FY08 [projected]	FY09 [projected]
Federal		**$107,000**	**$125,272**
	USDA-Forest Service	$75,000	$75,000
	National Park Service	$17,000	$17,000
	USDA-FS Fee Demo	$15,000	$15,000
	USDA-FS Carryover	$0	$15,211
Washington State		**$192,500**	**$207,000**
	Parks and Recreation Commission (includes State General Fund $)	$79,000	$79,000
	Department of Transportation	$45,000	$45,000
	WA Supplemental Budget	$58,000	$73,000
	Snowpark Program	$4,500	$4,500
	Snowmobile Program	$6,000	$6,000
County		**$8,000**	**$0**
	Title II/Resource Advisory Comm.	$8,000	$0
Private		**$40,000**	**$40,000**
	PNSAA	$15,000	$25,000
	FOAC	$5,000	$5,000
	Other private	$15,000	$15,000
TOTAL	**[*Direct Support]**	**$342,500**	**$374,711**
Estimated In-Kind Support (+3% in FY08 & 09)		**$184,711**	**$189,578**
[Indirect support]	USDA-FS (~30& of direct cont)	$22,500	$22,500
	WSDOT (obs + equip support)	$22,735	$23,417
	NPS (obs + equip support)	$5,458	$5,622
	NWS (office costs + product access etc)	$66,121	$68,105
	PNSAA (obs, power, phone etc)	$7,545	$7,771
	All (one time cost for data support)	$60,352	$62,163
GRAND TOTAL [DIRECT + INDIRECT]		**$527,211**	**$564,289**

Figure 35. NWAC—Projected FY08 Expenses

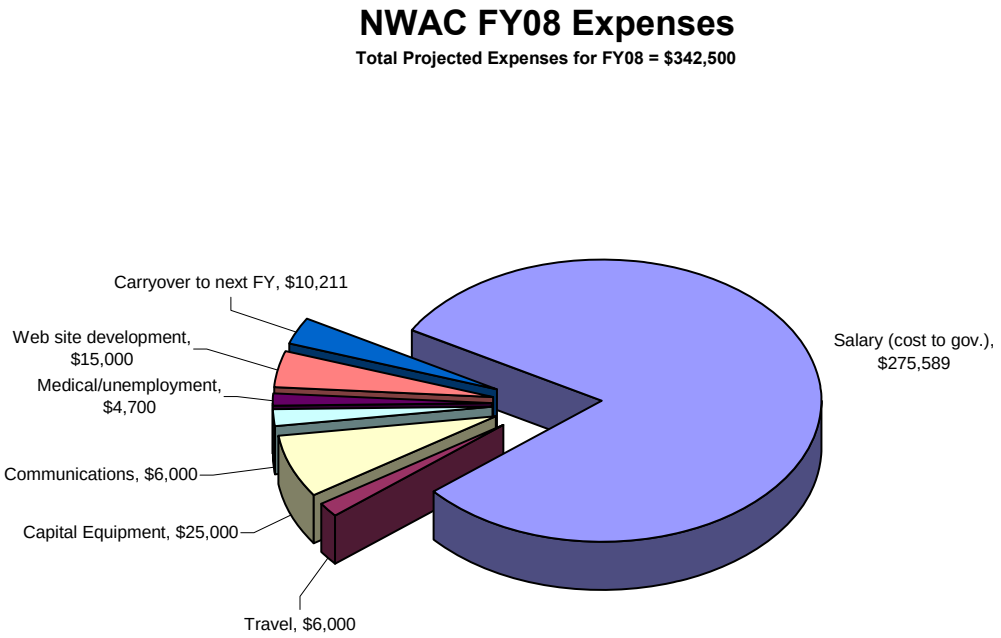
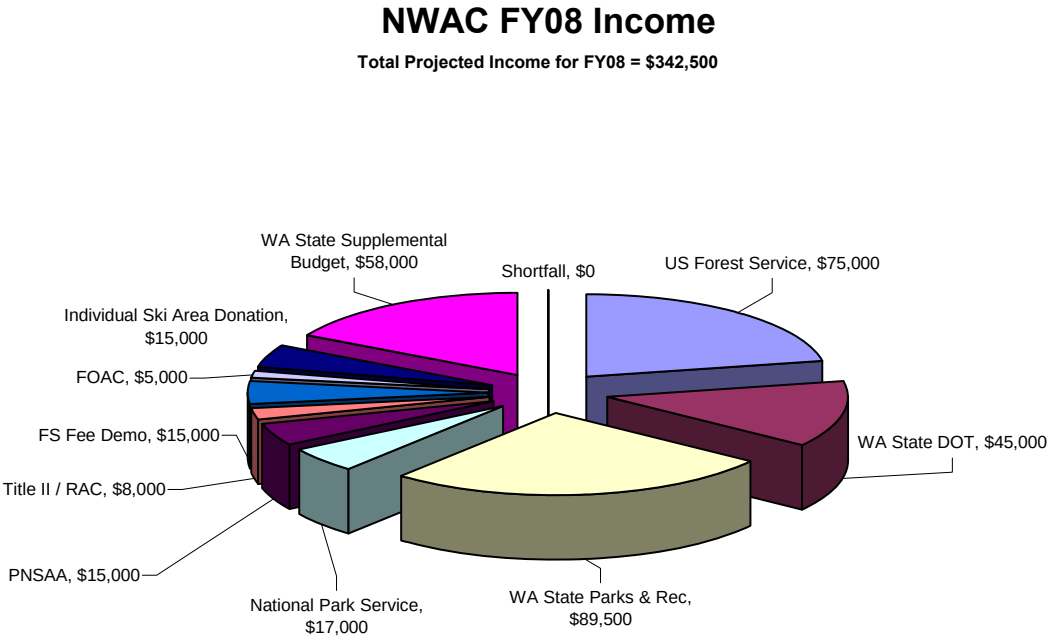


Figure 36. NWAC—Projected FY08 Income



NWAC STAFF

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

- **Mark Moore** – Director and forecaster at the NWAC since its inception in 1976. Focal point for budgeting, avalanche accident information, web site management and development, computer and weather station management. 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 RAWS instrumentation coordinator in the summer

- **Garth Ferber** – Forecaster at the NWAC since 1993. Focal point for weather station programs and data, forecast products, FOAC Snow Pack Information Exchange.

THE LAST WORD

Summer in the Northwest is really no big thing,
As westerly flows strong storms still bring.
That it's June or July doesn't bring me much ease,
When web cams still show new snow on the trees.

But at least we've made it through a very long winter,
To a time when the snowpack can settle and sinter.
But avalanche dangers may often persist—
As long as steep slopes and snow still coexist.

So throughout the summer and into the fall,
Think about the terrain, not the trip to the mall.
Heed the warnings that sun and warming may bring,
When unstable new snow is a pretty sure thing.

Although new snow may be shallow, bonding well to a crust—
When radiation hits, increased thought is a must.
Though stable snow in the morning is great fun you know—
Gravity and sun add stress, making it flow.

So no matter the month, no matter the season—
If you don't stay aware, the results won't be pleasin'.
It doesn't take much to keep your eyes open—
And a safe summer for you is what we're all hopin'.
- 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