

# ***Introduction to Forecasts and Verification***

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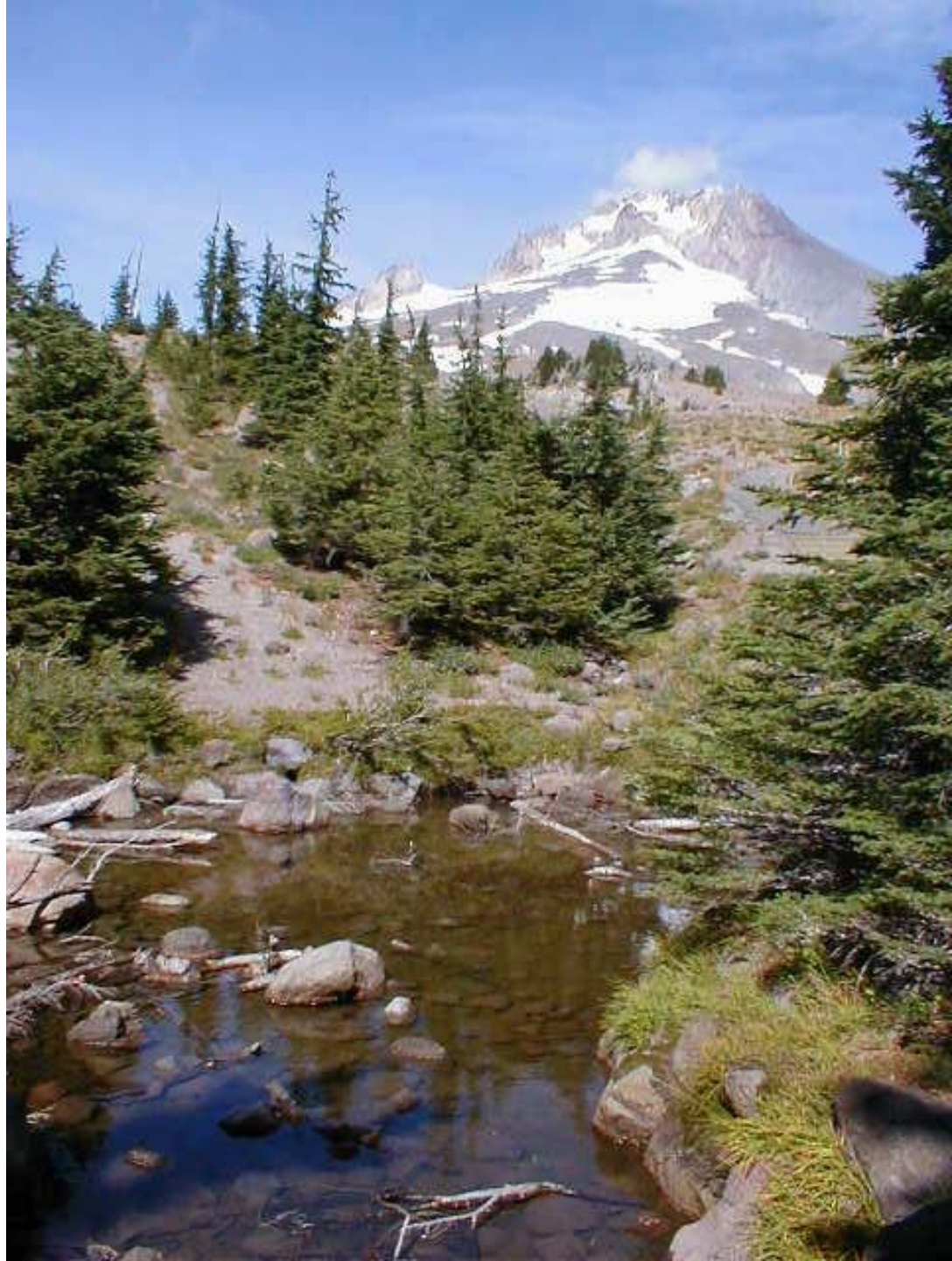


# Forecasts and decision-making

**What is a forecast?**

**What kinds of forecasts exist?**

**What makes a forecast good?**



# Predictions are everywhere!

Issued By: [Portland, Oregon](#) [\[Printable\]](#)

Point Forecast: Portland, OR










45.53N -122.67W (Elev. 200 ft)

[Text Forecast \(°C\)](#) [En Español](#)

Last Update: 9:37 am PST Feb 5, 2008

Forecast Valid: 1pm PST Feb 5, 2008-6pm PST Feb 11, 2008

## Forecast at a Glance

This Afternoon	Tonight	Wednesday	Wednesday Night	Thursday	Thursday Night	Friday	Friday Night	Saturday
								
100%	90%	70%	100%	80%	50%	60%		
Rain	Showers	Rain Likely	Rain	Rain	Chance Showers	Rain Likely	Chance Rain	Showers Likely
Hi 45°F	Lo 37°F	Hi 44°F	Lo 37°F	Hi 44°F	Lo 40°F	Hi 45°F	Lo 39°F	Hi 47°F

## Weather forecasts

# Predictions are everywhere!

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Point Forecast: Portland, OR

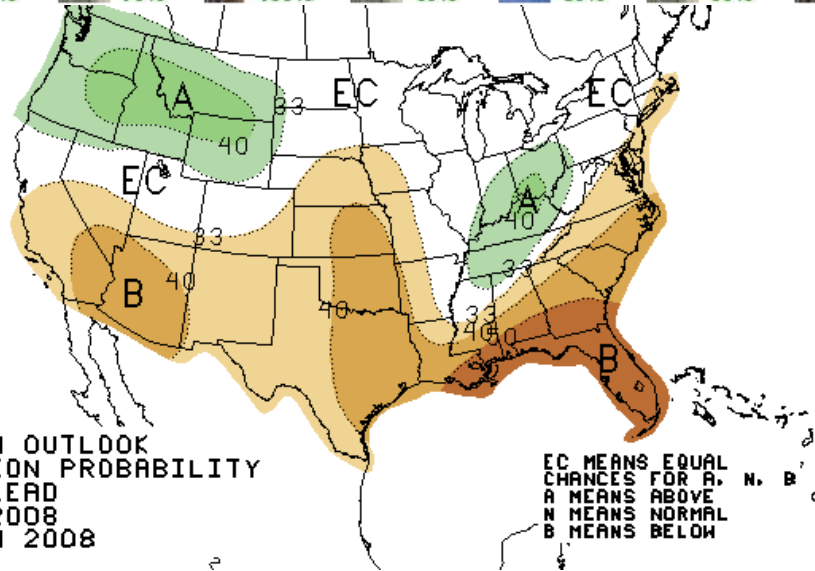
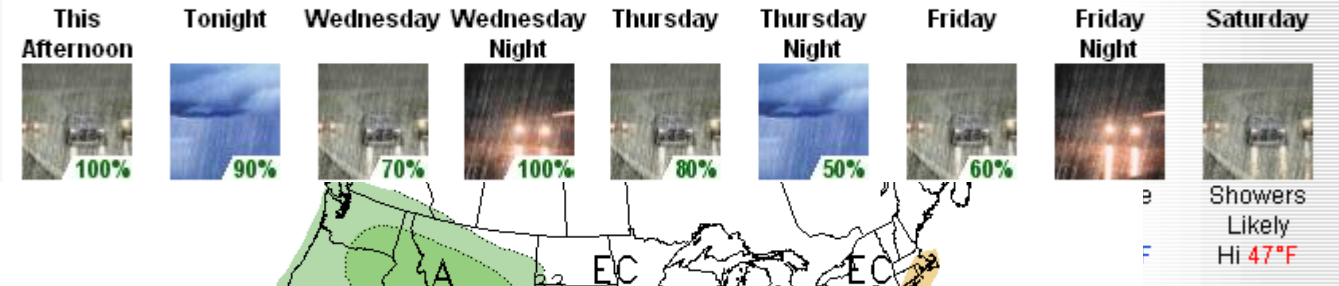
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## Forecast at a Glance



THREE-MONTH OUTLOOK  
 PRECIPITATION PROBABILITY  
 0.5 MONTH LEAD  
 VALID FMA 2008  
 MADE 17 JAN 2008

**Weather forecasts**

**Climate forecasts**

# Predictions are everywhere!

Issued By: **Portland, Oregon** [Printable]

Point Forecast: Portland, OR

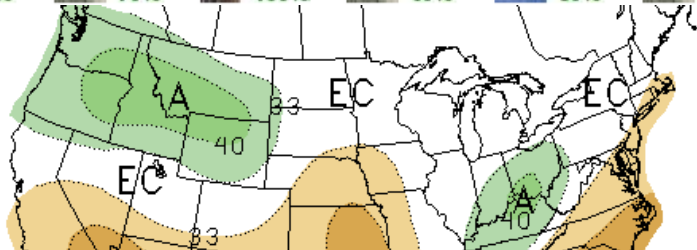
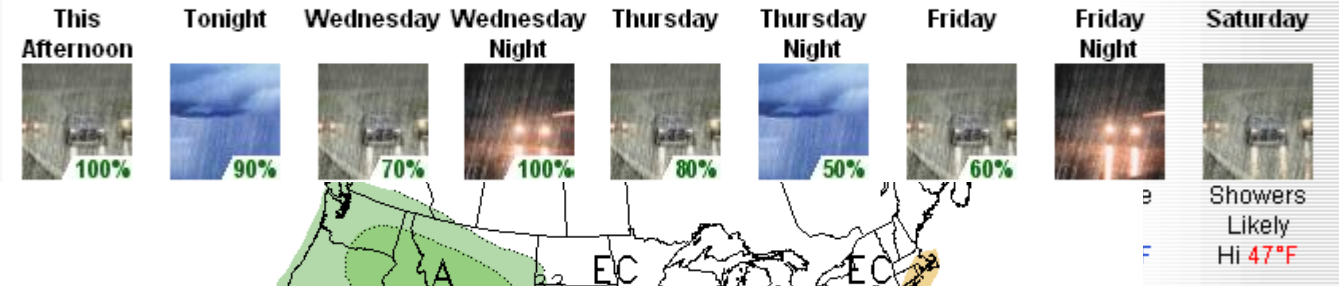
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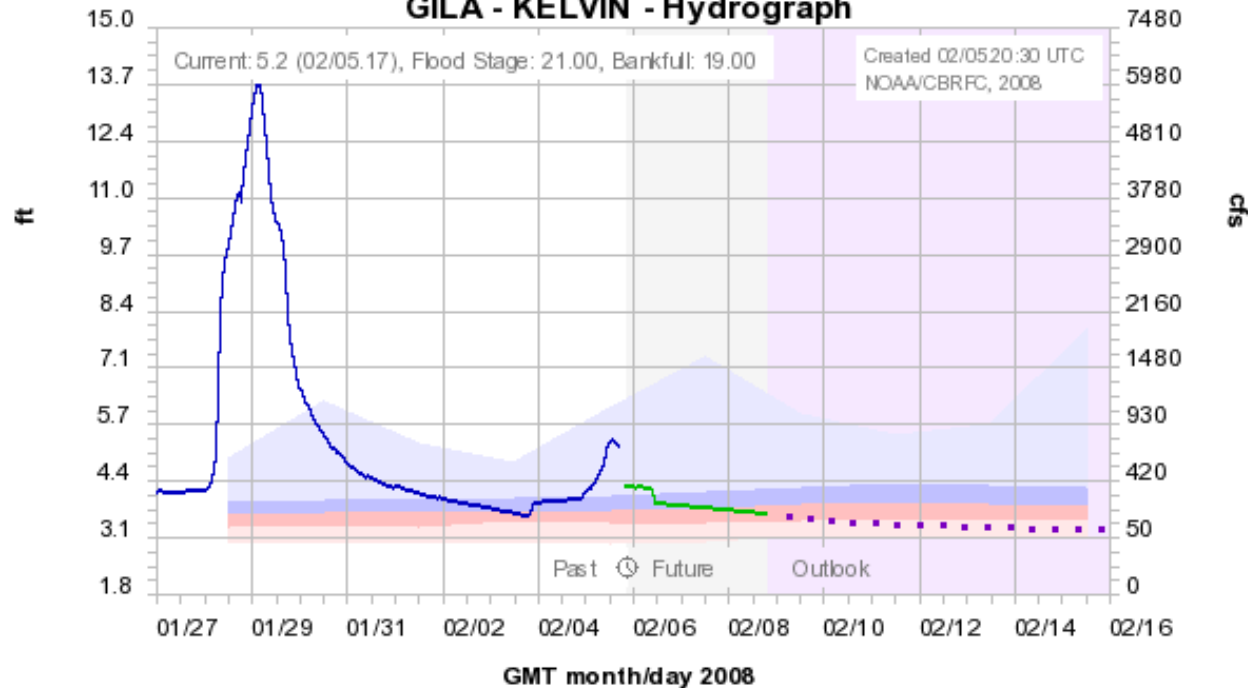
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## Forecast at a Glance



GILA - KELVIN - Hydrograph



Weather forecasts

Climate forecasts

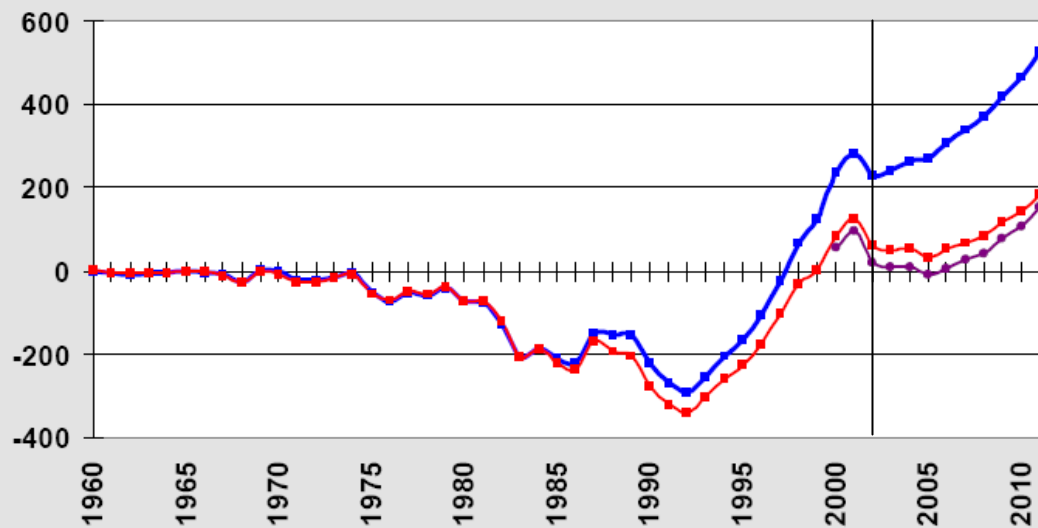
River Forecasts

**Whether you use a “forecast” product or not,  
almost all resource decisions assume something  
about the future (and not just for climate...)**

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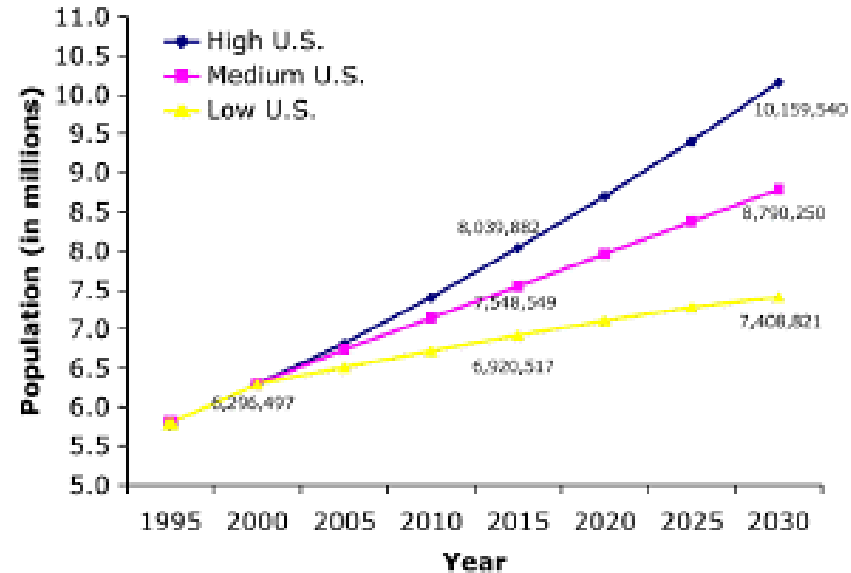
## Population

**Federal Budget Deficit (or Surplus), FY 1960-2011**  
in billions of dollars (President's APRIL '01 proposals)



- Unified budget (incl. Social Security)
- On-budget (excludes Social Security)
- Surplus excl. SS and Medicare trust funds

## Population Projections for the U.S. Border Region



## Budgets

# The focus of today: Seasonal water supply volume forecasts (available in a variety of formats) NRCS formats:

```

=====
                        RIO GRANDE BASIN
                        Streamflow Forecasts - April 1, 2002
=====
Forecast Pt | <=== Drier === Future Conditions === Wetter ===> |
Forecast | ===== Chance of Exceeding * ===== |
Period | 90%      70% | 50% (Most Prob) | 30%      10% | 30 Yr Avg
          |(1000AF) (1000AF)| (1000AF) (% AVG.)| (1000AF) (1000AF)| (1000AF)
=====
Rio Grande nr Del Norte
  APR-SEP      129      157      177      33      242      339      531

Platoro Reservoir Inflow
  APR-JUL      12.0     19.7      25      39      30      38      64
  APR-SEP       23      27      29      41      35      43      71

Conejos River nr Mogote
  APR-SEP       57      68      75      38      95      125     200

```

# The focus of today: Seasonal water supply volume forecasts (available in a variety of formats) NRCS formats:

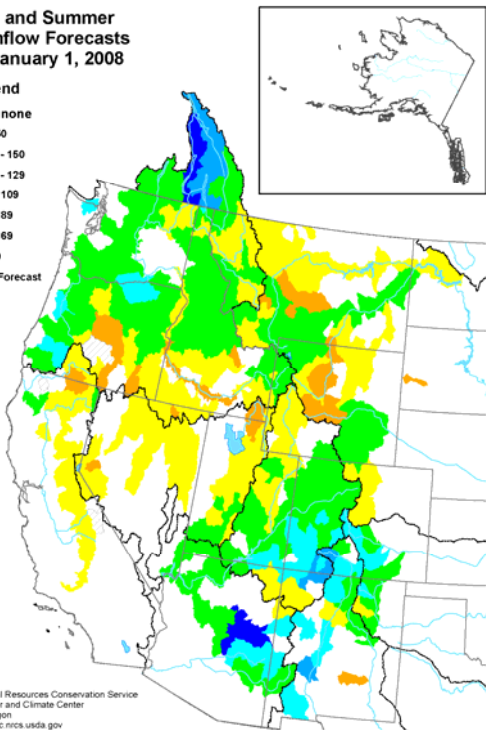
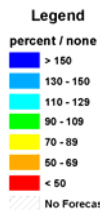
February, 2008 Streamflow Forecast Probability Chart for Utah

E. GARFIELD, KANE, WASHINGTON, & IRON Co. Percent Exceedance Forecasting Charts

DATA CURRENT AS OF: 2/05/08 08:02:13

Location / Period	90% Exceedance	77%
	<b>Lake Powell Inflow (2)</b> APR-JUL Average = 7930.0	70% Exceedance
	50% Exceedance	120% (9500.00)
	30% Exceedance	137%
	10% Exceedance	163%
<b>Virgin River at Virgin</b> APR-JUL Average = 64.0	90% Exceedance	88%
	70% Exceedance	114%
	50% Exceedance	133% (85.00)
	30% Exceedance	153%
	10% Exceedance	186%

Spring and Summer Streamflow Forecasts as of January 1, 2008

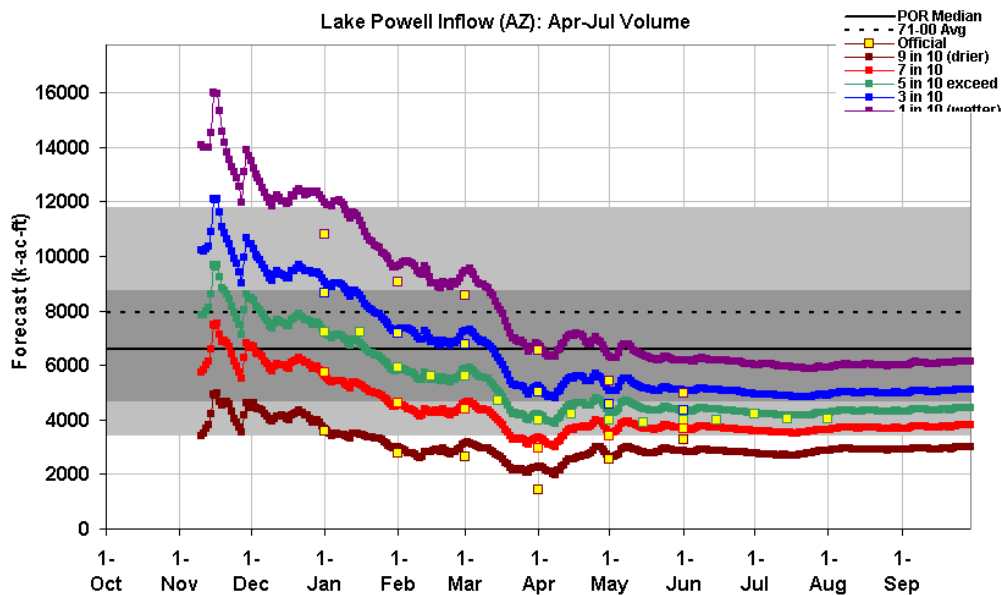


RIO GRANDE BASIN  
Streamflow Forecasts - April 1, 2002

<=== Drier === Future Conditions === Wetter ===>

Forecast Pt	Chance of Exceeding *					
Forecast Period	90% (1000&F)	70% (1000&F)	50% (Most Prob) (1000&F) (% AVG.)	30% (1000&F)	10% (1000&F)	30 Yr Avg (1000&F)
<b>Rio Grande nr Del Norte</b>						
APR-SEP	129	157	177	33	242	339
<b>Platoro Reservoir Inflow</b>						
APR-JUL	12.0	19.7	25	39	30	38
APR-SEP	23	27	29	41	35	43
<b>Conejos River nr Mogote</b>						
APR-SEP	57	68	75	38	95	125

Lake Powell Inflow (AZ): Apr-Jul Volume



This is an automated product based solely on SNOTEL data, provisional data are subject to change. This product is a statistically based guidance forecast combining indices of snowpack and precipitation. **Yellow squares** are the official outlooks. **Gray background** is the historical period of record variability. This product does not consider climate information such as El Niño or short range weather forecasts, or a variety of other factors considered in the official forecasts. This product is not meant to replace or supersede the official forecasts produced in coordination with the National Weather Service. Science Contact: Tom.Pagano@por.usda.gov 503 414 3010 www.wcc.nrcs.usda.gov/wsf/daily\_forecasts.html

Created 12:17 Nov 6 2007



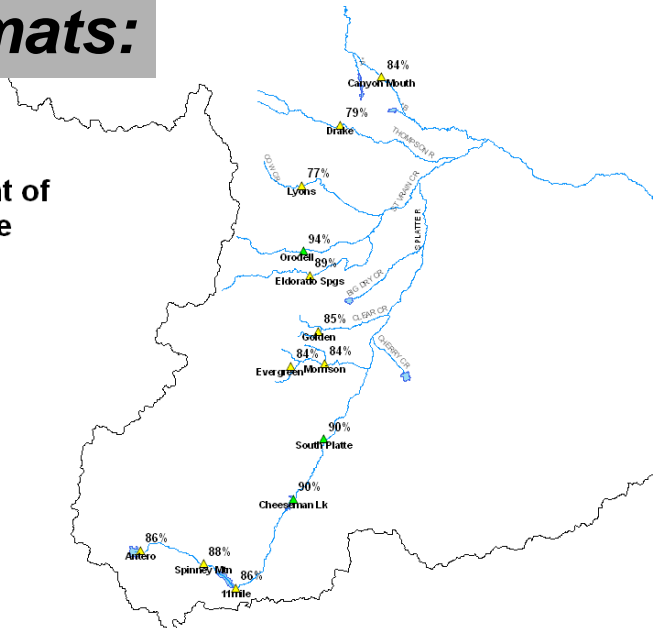
# NWS formats:

Stream and Station	Forecast Period	Forecasts This Year				30 Year
		Most Probable kaf	Reasonable Max %avg	Reasonable Min %avg	Average Runoff kaf	
<b>Saskatchewan River Basin</b>						
St. Mary River						
Babb nr, MT	Apr-Sep	350	78	97	59	450
<b>Missouri River Basin</b>						
Red Rock River						
Lima Res inflow, MT	Apr-Sep	76	73	118	55	104
Beaverhead River						

# NWS formats:

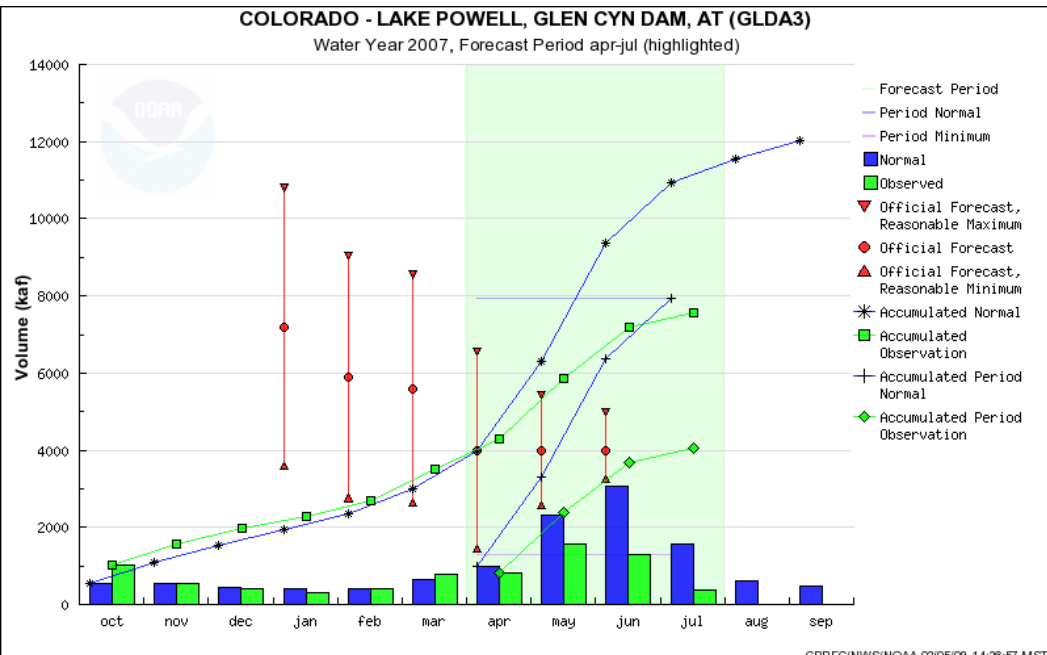
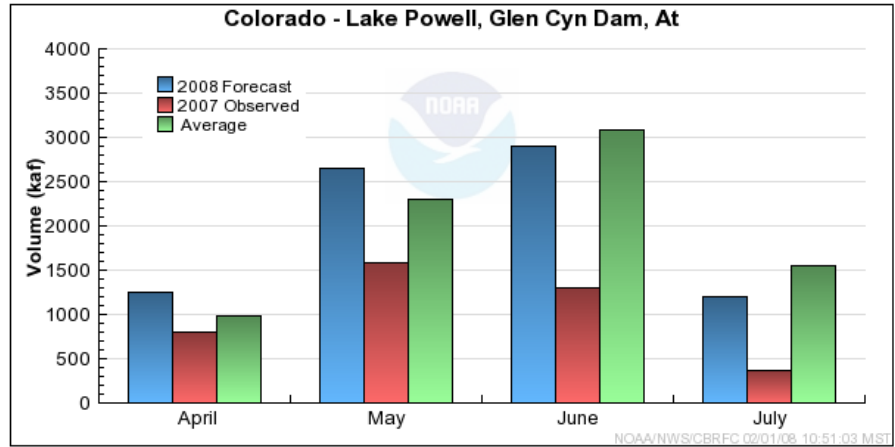
## Forecast as Percent of 1971-2000 Average

- ▲ >150%
- ▲ 130% - 150%
- ▲ 110% - 129%
- ▲ 90% - 109%
- ▲ 70% - 89%
- ▲ 50% - 69%
- ▲ < 50%

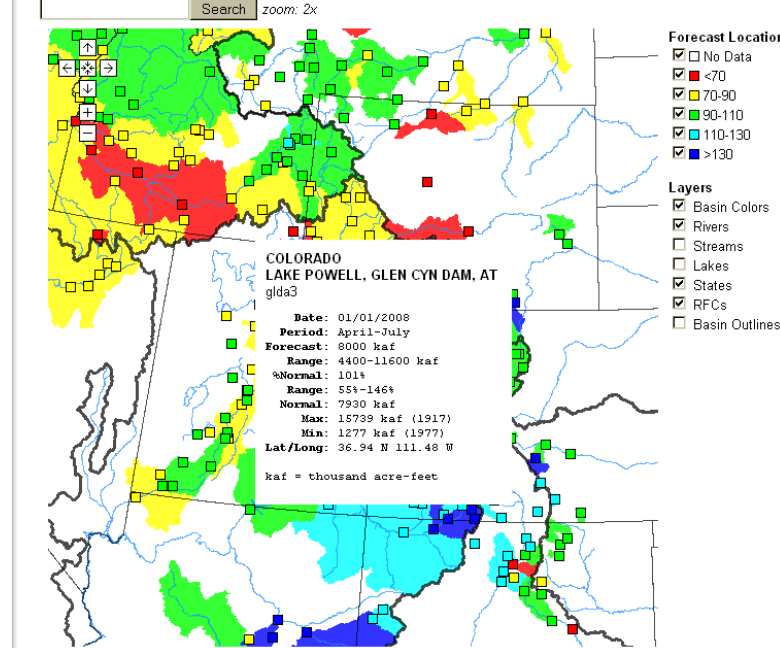


Stream and Station	Forecast Period	Most Probable kaf	Reasonable Max %avg	Reasonable Min %avg	30 Year Average Runoff kaf
<b>Saskatchewan River Basin</b>					
St. Mary River					
Babb nr, MT	Apr-Sep	350	78	97	59
<b>Missouri River Basin</b>					
Red Rock River					
Lima Res inflow, MT	Apr-Sep	76	73	118	55
Beaverhead River					

Issued by the Missouri Basin River Forecast Center in cooperation with the National Resources Conservation Service



## Seasonal Runoff Volume Forecasts



# Elements of a forecast: Location, Time, Magnitude, Probability

```

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                                RIO GRANDE BASIN
                                Streamflow Forecasts - April 1, 2002
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                                <=== Drier === Future Conditions === Wetter ===>
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Forecast    | 90%      70%  | 50% (Most Prob) | 30%      10%  | 30 Yr Avg
Period      | (1000AF) (1000AF) | (1000AF) (% AVG.) | (1000AF) (1000AF) | (1000AF)
=====
Rio Grande nr Del Norte
  APR-SEP      129      157      177      33      242      339      531

Jemez River nr Jemez
  MAR-JUL      2.3      3.4      4.2      9      12.7      25      47

Jemez Canyon Reservoir inflow
  MAR-JUL      1.1      2.1      2.7      7      11.9      25      38

Rio Grande at San Marcial
  MAR-JUL      3.0      7.0      10.0     2      147      349      573

```

**Location**

Rio Grande at San Marcial





# Ways of expressing a forecast:

**Categorical** – “It will be warm”

**Deterministic** – “It will be 103% of normal”

**Probabilistic** – “There is a 50% chance of being more than 23 kaf”

Issued By: **Portland, Oregon**  
Point Forecast: Portland, OR  
45.53N -122.67W (Elev. 200 ft)

## Forecast at a Glance

This  
Afternoon

Tonight

We

Rain

Showers

Hi 45°F

Lo 37°F



## Ways of expressing a forecast:



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Issued By: **Portland, Oregon**  
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### Forecast at a Glance

	This Afternoon	Tonight	We
	Rain	Showers	
	Hi 45°F	Lo 37°F	
			
	100%	90%	

Red arrow points to 'Rain' and 'Hi 45°F'.

Blue arrow points to 'Hi 45°F'.

Purple arrow points to '100%'.

## Ways of verifying forecasts:

**Categorical** – Did you predict the right category?

**Deterministic** – Was the observed amount very far from the forecast?

**Probabilistic** – Was the outcome unlikely?

# Water supply forecasts are probabilistic at their core, but most products are deterministic

average, down slightly from the amounts reported last year at this time. Near normal streamflows are forecast for most forecast points in the basin. Expected runoff will range from 88 percent of average for Muddy Creek below Wolford Mountain Reservoir to 106 percent of average for the Inflow to Ruedi Reservoir and the Roaring Fork at Glenwood Springs.

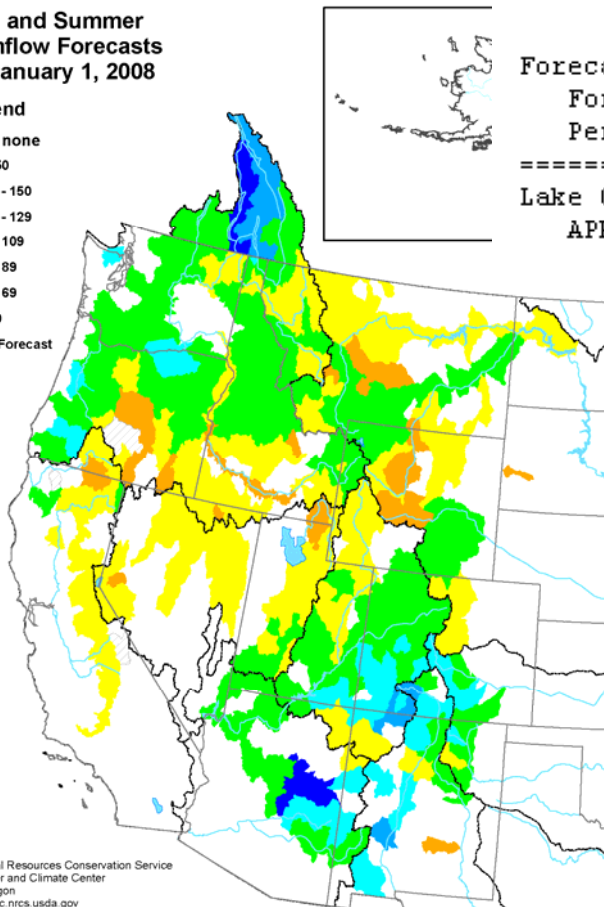
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UPPER COLORADO RIVER BASIN  
Streamflow Forecasts - January 1, 2008

=====

Forecast Pt	Future Conditions					30 Yr Avg
	90%	70%	50%	30%	10%	
Forecast Period	(1000AF)	(1000AF)	(1000AF) (% AVG.)	(1000AF)	(1000AF)	(1000AF)
Lake Granby Inflow (2)						
APR-JUL	155	187	210 93	235	273	225

## Spring and Summer Streamflow Forecasts as of January 1, 2008



Timely, Reliable Information  
for Western Agriculture

- HOME
- GRAPES
- RICE
- ALFALFA
- NUTS
- VEGETABLES
- COTTON
- CITRUS/ORCHARDS
- EN

## First Arizona NRCS 2008 snow pack report: Close to 30-year average, normal spring runoff expected

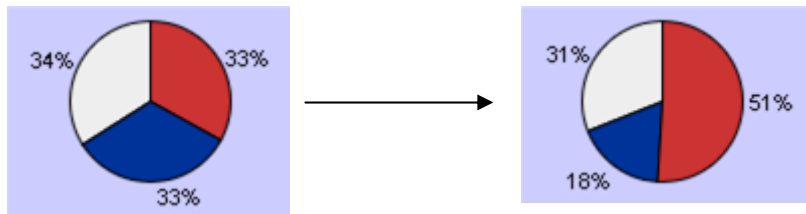
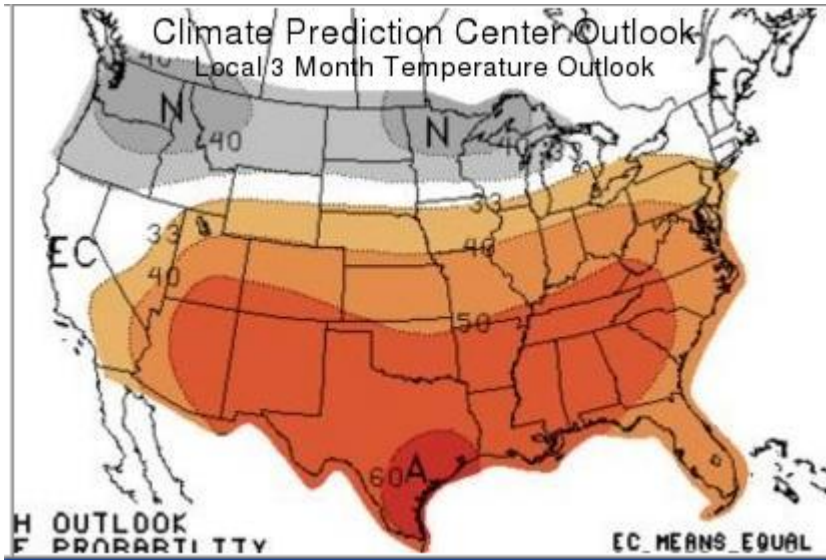
Jan 8, 2008 10:21 AM

- SAVE THIS
- EMAIL THIS
- PRINT THIS
- MOST POPULAR

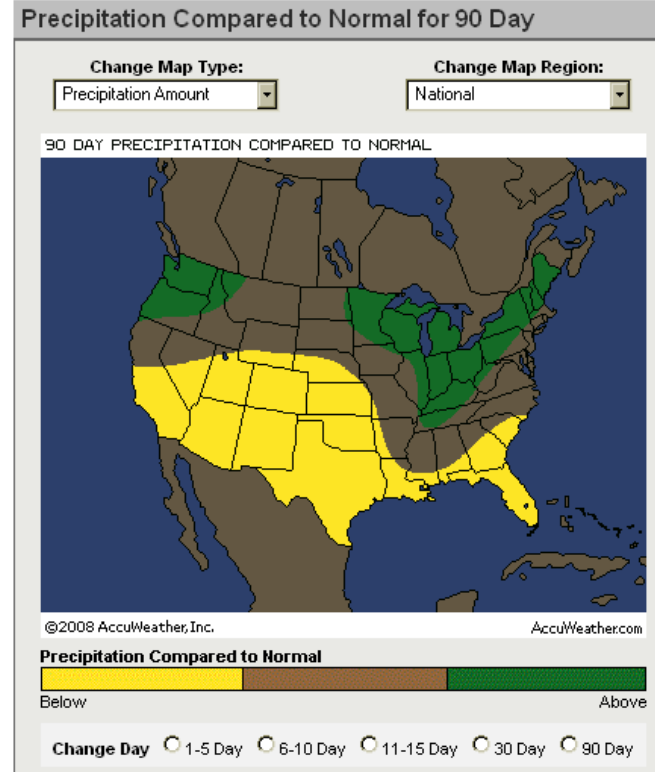
Water resources specialists from the Arizona Natural Resources Conservation Service (NRCS) and cooperating partners are forecasting normal spring runoff in Arizona's major rivers and streams based on recent snowpack measurements in Arizona's mountain watersheds.

Statewide, the January 1 snowpack measured 93-percent of the 30-year average, compared with 38-percent a year ago. The Salt River and San Francisco-Upper Gila River Basins have slightly above normal snow levels for this time of year, but the Verde River and Little Colorado River Basins are below normal for January 1.

# Climate forecasts are probabilistic too, but mostly they're discussed categorically



## Tilts in the odds



January 7, 2008 - 10:11PM

Double-click any word or phrase in the story to search this site.

## Experts baffled but happy about precipitation

Comments 4 | Recommend 1

MIKE BRANOM, TRIBUNE

The winter of 2006-07 was predicted to be wet, but it was bone-dry. The drought was forecast to continue this winter, but Arizona just enjoyed yet another rainy, snowy weekend.

### Rain helps refill Canyon Lake Valley sees an inch of rain, heavy snow upstate

At Salt River Project, the water experts don't know what's going on — and don't really care as long as precipitation fills the lakes.

## What is the “Climatology” or “Equal Chances” forecast?

**The safest forecast in the absence of skill or a signal...  
“The outcome will be between zero and infinity”**

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**Try a little harder...**

**“The range of temperatures observed on earth”**

**Keep trying...**

**“The typical range of temperatures in Durango in January”**

## What is the “Climatology” or “Equal Chances” forecast?

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**“The outcome will be between zero and infinity”**

**Try a little harder...**

**“The range of temperatures observed on earth”**

**Keep trying...**

**“The typical range of temperatures in Durango in January”**

**But what is “typical”?**

**Standard definition is the 30-year normal, 1971-2000**

**Long enough to be stable, recent enough to be relevant**

**“Naïve baselines” are useful for determining  
how much “better” a forecasting system is, comparatively**

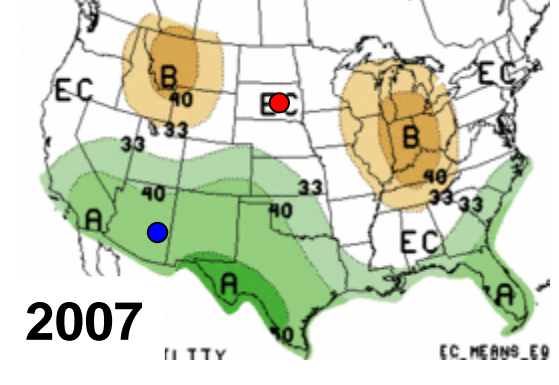
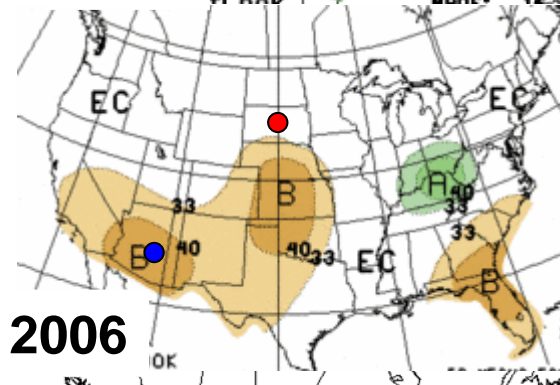
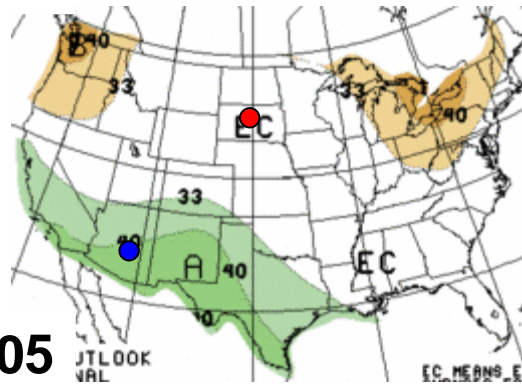
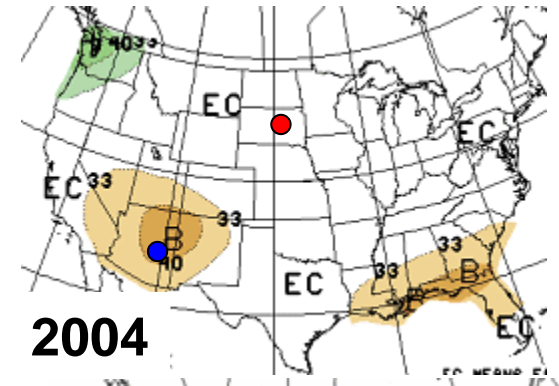
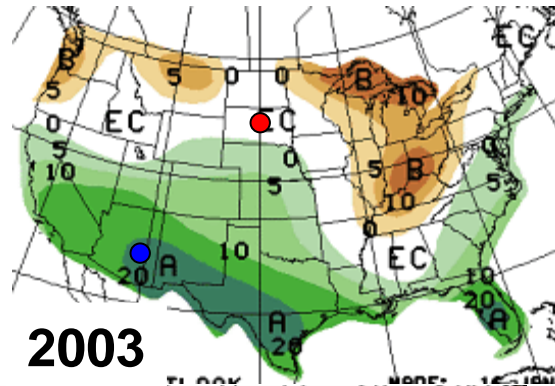
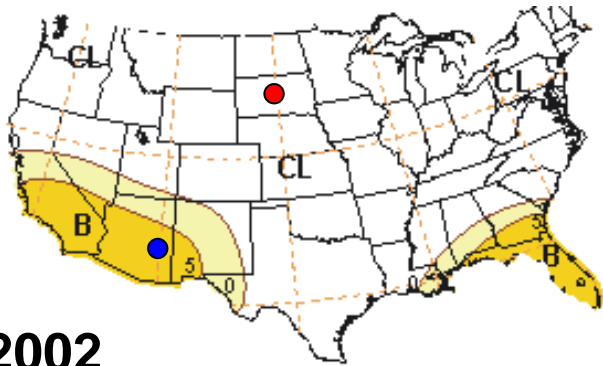
**Interestingly, there is no “Equal Chances”  
forecast in hydrology...**

## Resolution versus Reliability

**Resolution/Sharpness: How confident are your forecasts? How much do they differ from climatology? How much do you go out on a limb?**

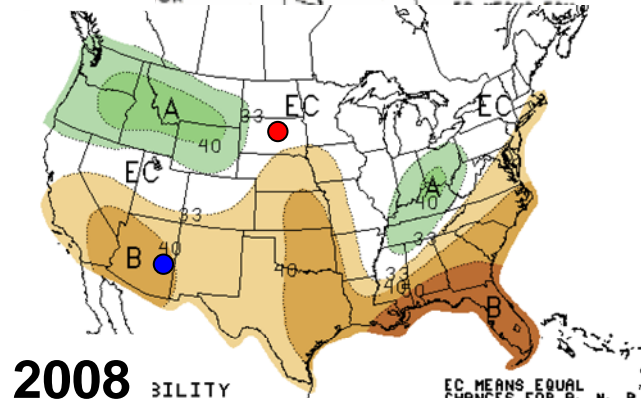
# Resolution versus Reliability

**Resolution/Sharpness: How confident are your forecasts? How much do they differ from climatology? How much do you go out on a limb?**



- Never says anything interesting
- Forecast often relatively strong

**Feb-Apr  
precipitation  
forecasts  
Issued Jan 15**



## Resolution versus Reliability

**Reliability: Are you going out on the right limb?  
When you make a statement, is it generally correct?  
e.g. When you say there's a 30% chance of rain,  
does it rain 30% of the time?**

# Resolution versus Reliability

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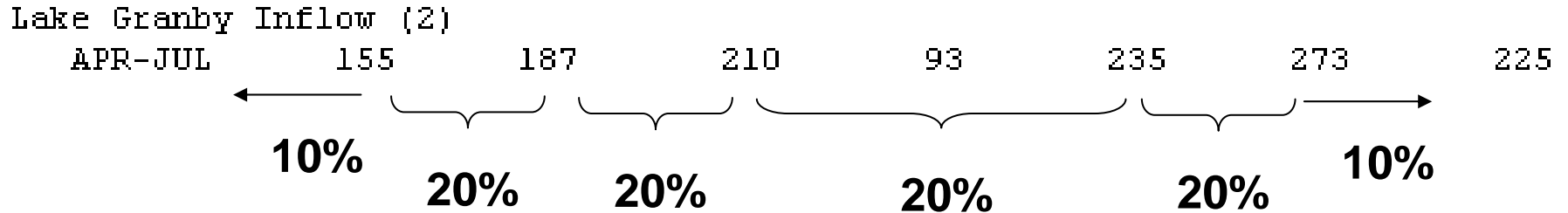
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UPPER COLORADO RIVER BASIN  
 Streamflow Forecasts - January 1, 2008

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	Future Conditions						
	<=== Drier ===			=== Wetter ===>			
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=====



**Percent of time the observed should fall in different categories**

## Forecast “Appropriateness”

**Is this the most appropriate forecast given the information at hand?**

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Is this the most appropriate forecast given the information at hand?

**07M31S**

**Animas at Durango**

<u>Year</u>	<u>Apr 1 snow</u>	<u>Apr-Jul fcst</u>	<u>Apr-Jul obs</u>	<u>Fcst - Obs</u>
<b>2006</b>	<b>57%</b>	<b>68%</b>	<b>68%</b>	<b>0%</b>
<b>2007</b>	<b>54%</b>	<b>68%</b>	<b>89%</b>	<b>-18%</b>

**Was 2007 a “bad” forecast?**

## Forecast “Appropriateness”

Is this the most appropriate forecast given the information at hand?

**07M31S**

**Animas at Durango**

<u>Year</u>	<u>Apr 1 snow</u>	<u>Apr-Jul fcst</u>	<u>Apr-Jul obs</u>	<u>Fcst - Obs</u>
<b>2006</b>	<b>57%</b>	<b>68%</b>	<b>68%</b>	<b>0%</b>
<b>2007</b>	<b>54%</b>	<b>68%</b>	<b>89%</b>	<b>-18%</b>

**Was 2007 a “bad” forecast?**

**In 2007, Apr-Jun precipitation was >400% what it was in 2006.**

**2006 Apr-Jul precip 3<sup>rd</sup> lowest on record.**

**Maybe 2006 was the “bad” forecast with a lucky outcome?**

# **Skill and Value are different**

**Consider also:**

**Timeliness**

**Cost to produce**

**Understandability**

**Relevance**

**Specificity**

**Transparency**

**Credibility**

**Ability to use**

**Skill is probably one of  
the hardest things on the list to improve**

# Summary

**3 Classes of Forecasts:  
Categorical, Deterministic, Probabilistic**

**At their core, all forecasts are probabilistic,  
but derived products are not.**

**Resolution: How often do you show up for “exams”?  
Reliability: What is your score on exams you do take?**

**Appropriateness:  
Are you using the best information on hand?**

**Skill is only one part of value and  
is one of the hardest things to improve**