Columbia River Flows

Presentation to the

Vancouver Lake Watershed Partnership

April 20, 2005

Chris Hathaway

Columbia River Background

- 259,000 square mile watershed
- Drains portions of 7 states, 2 provinces
- 1200 miles long
- Average discharge 275,000 cfs
- Primarily snowmelt driven system
- Second to Missouri-Mississippi in volume
- Major tributaries include:
  - Kootenai, Flathead/Pend Oreille, Snake River, and Willamette River

Lower Columbia River

- Bonneville Dam to the Pacific Ocean
- 146 river miles
- Watershed of approximately 18,000 square miles
- Major tributaries include:
  - Sandy, Washougal, Willamette, Lewis, Kalama, Cowlitz

Geography

- River emerges from a steep walled Gorge below Washougal
- Stretch from Washougal to Longview
  - Broad floodplain
  - Elongated islands (Reed, Government, Hayden, Sauvie, Bachelor)
  - Sloughs, side channels, etc.
  - Last remnants of huge swamp riparian system formerly nourished by annual flooding

Riparian Swamp System

- Sandy River Delta
- Smith and Bybee Lake
- Vancouver Lake
- Sauvie Island
- Ridgefield Wildlife Refuge

- Each an example of the type of floodplains habitats and wetlands once abundant in the lower Columbia River.

Vancouver Lake

- Formerly connected to Columbia River via Mullligan Slough and Lake River
- Complex floodplain habitat
- Network of sloughs, wetlands, and channels that likely moved around with some frequency in response to annual flooding.

A Changed River

- Development
- Diking and draining
- Agriculture
- Dredging
- Dam building and flow regulation

Hydrologic Conditions

- Columbia River flows (and habitats) have been impacted by:
  - Dam Construction and Operation
  - Irrigation Withdrawals
  - Shoreline Anchoring
  - Channel Dredging
  - Channelization

Flow Regulation

- 29 Major federal dams in Columbia River basin
- Dozens of non-federal dams
- Hundreds of smaller dams
- One of the worlds' largest hydroelectric systems

Highly Managed System

- Primary system operations driven by a blend of
  - Flood control
  - Fish migration
  - Power needs
  - Navigation, Irrigation, Recreation, Water supply and water quality.

Hydro System Operation

- Based on meeting several related, sometimes conflicting objectives
  - Providing adequate flood storage space for control of spring runoff
  - Accommodating in-season management of fish passage, spawning, and stranding while providing flows to aid juvenile migration downstream and managing water quality

Management Objectives Cont.

- Maintaining high probability that reservoirs will refill to meet recreation needs and provide water for next year’s power and fish operations
- Preserving and enhancing habitat for resident fish
- Optimizing power generation within the requirements necessary to meet other objectives

Flow Changes (Volume)

- Since 1933 river flows have been substantially altered
- Water losses from irrigation, reservoir evaporation, and climate change have resulted in annual flows at The Dalles that are about 17% less that 19th century virgin flows

Flow Changes (Timing)

- Flow timing has changed more significantly than mean flow
- Decreased spring freshet magnitude
- Increased rest of year flows
- Flow more evenly distributed over the year (a flattened hydrograph)

Columbia River Flows

- About 97% of the flow of the total Columbia River flow passes the gauge at The Dalles.
- Since 1969 average spring freshet flows at The Dalles have been reduced by 50-55% and winter flows (October-March) have increased by 35%.
- The same pattern has been observed at Bonneville Dam
- This is most attributable to flow reduction. About is 20% to irrigation withdrawals, and only 5% climate change.

Current regulated mean monthly flow compared to historical unregulated mean monthly flow at Bonneville Dam (USACE 2001)

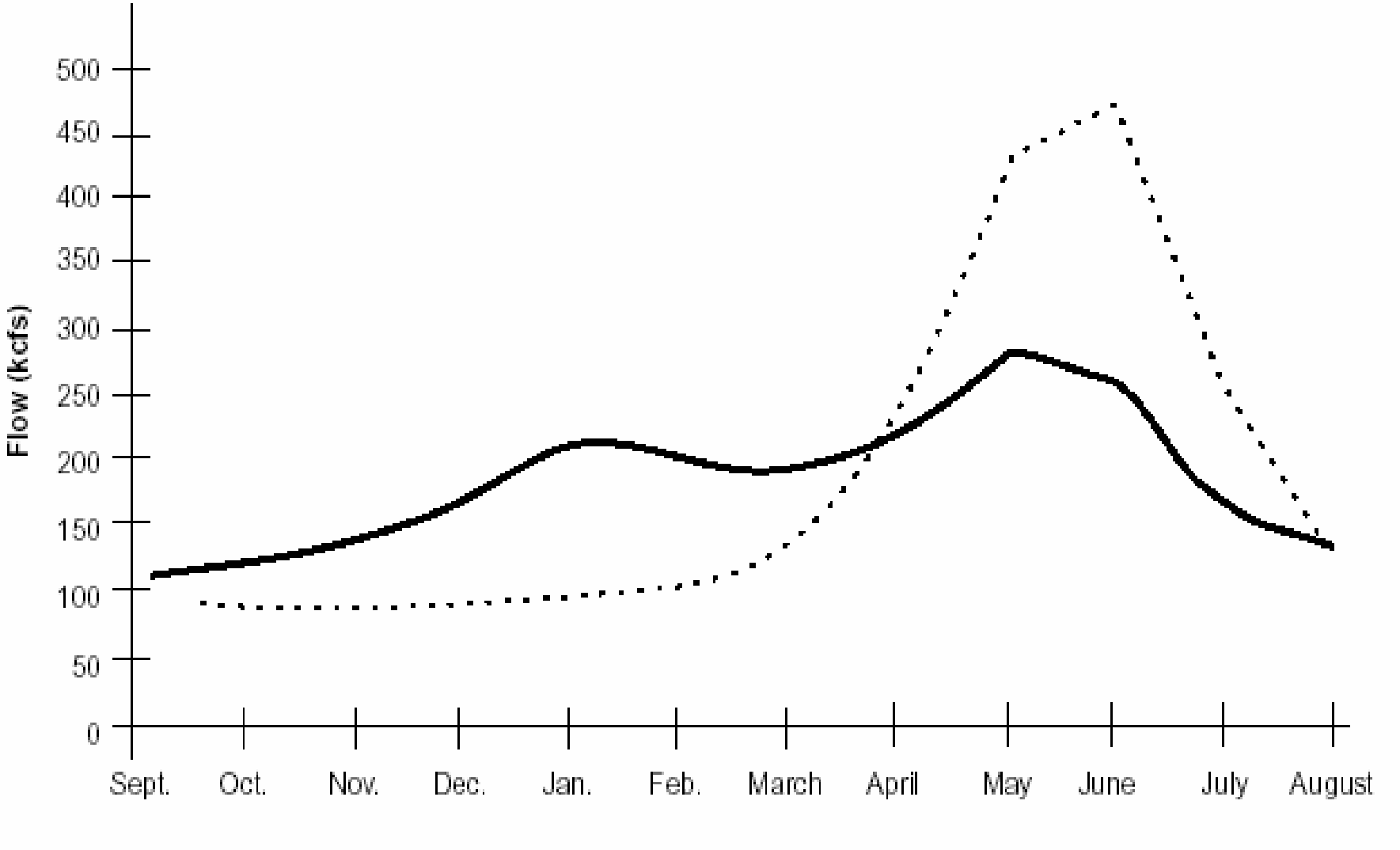
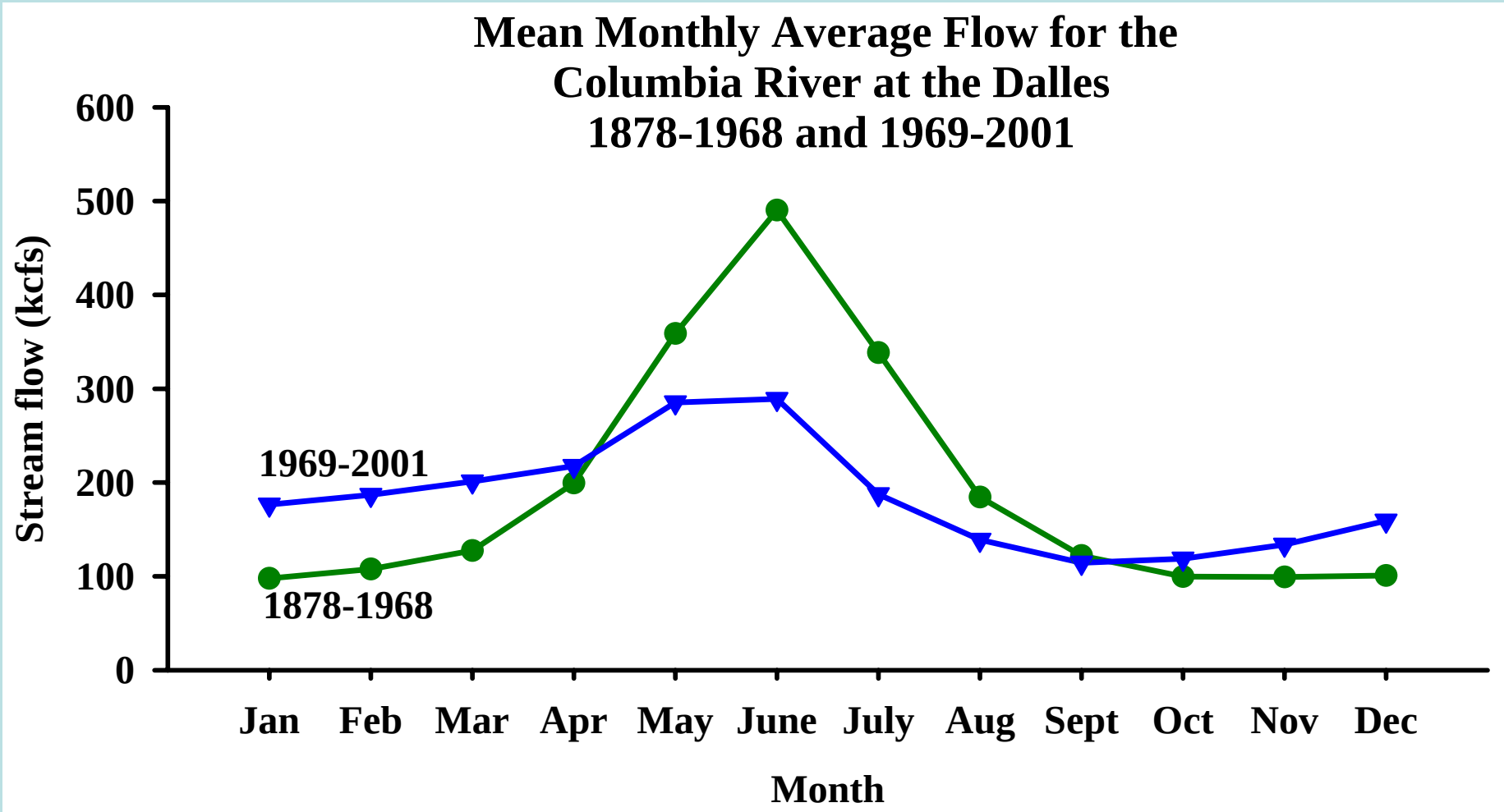
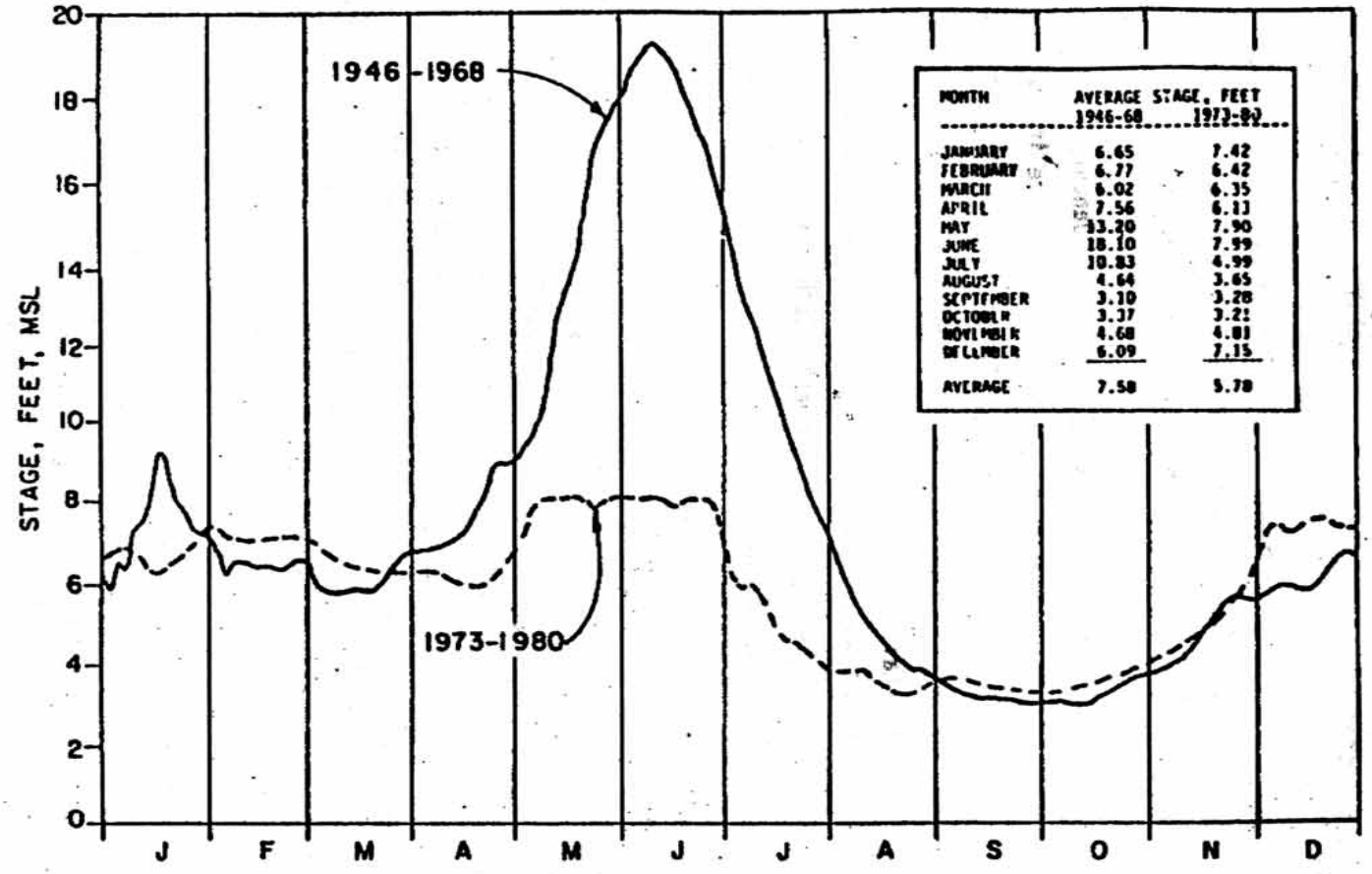


Figure 2-13. Mean monthly average flow at The Dalles. Construction of flow regulating dams has resulted in modification of the annual hydrograph of the Columbia River.



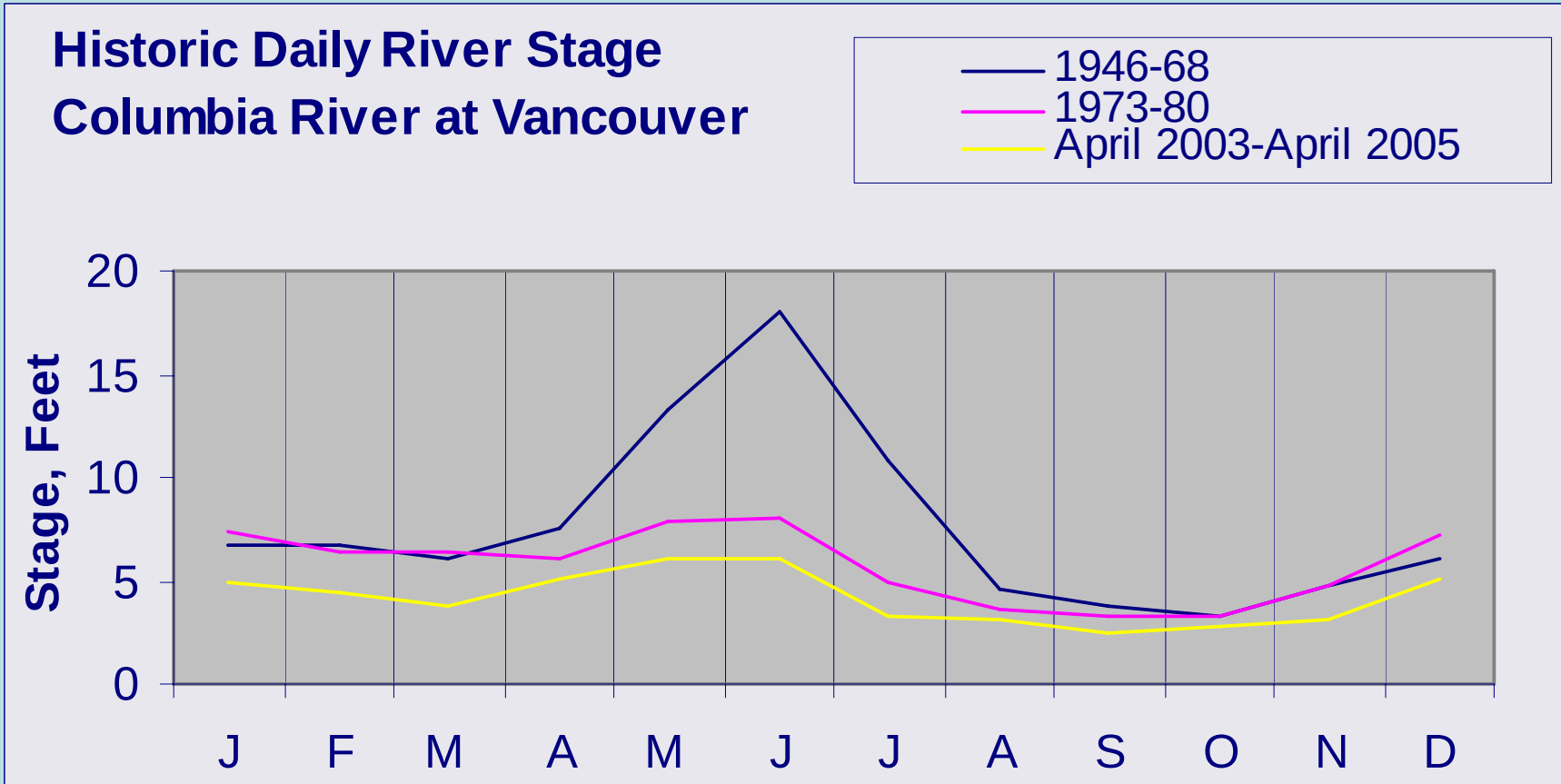


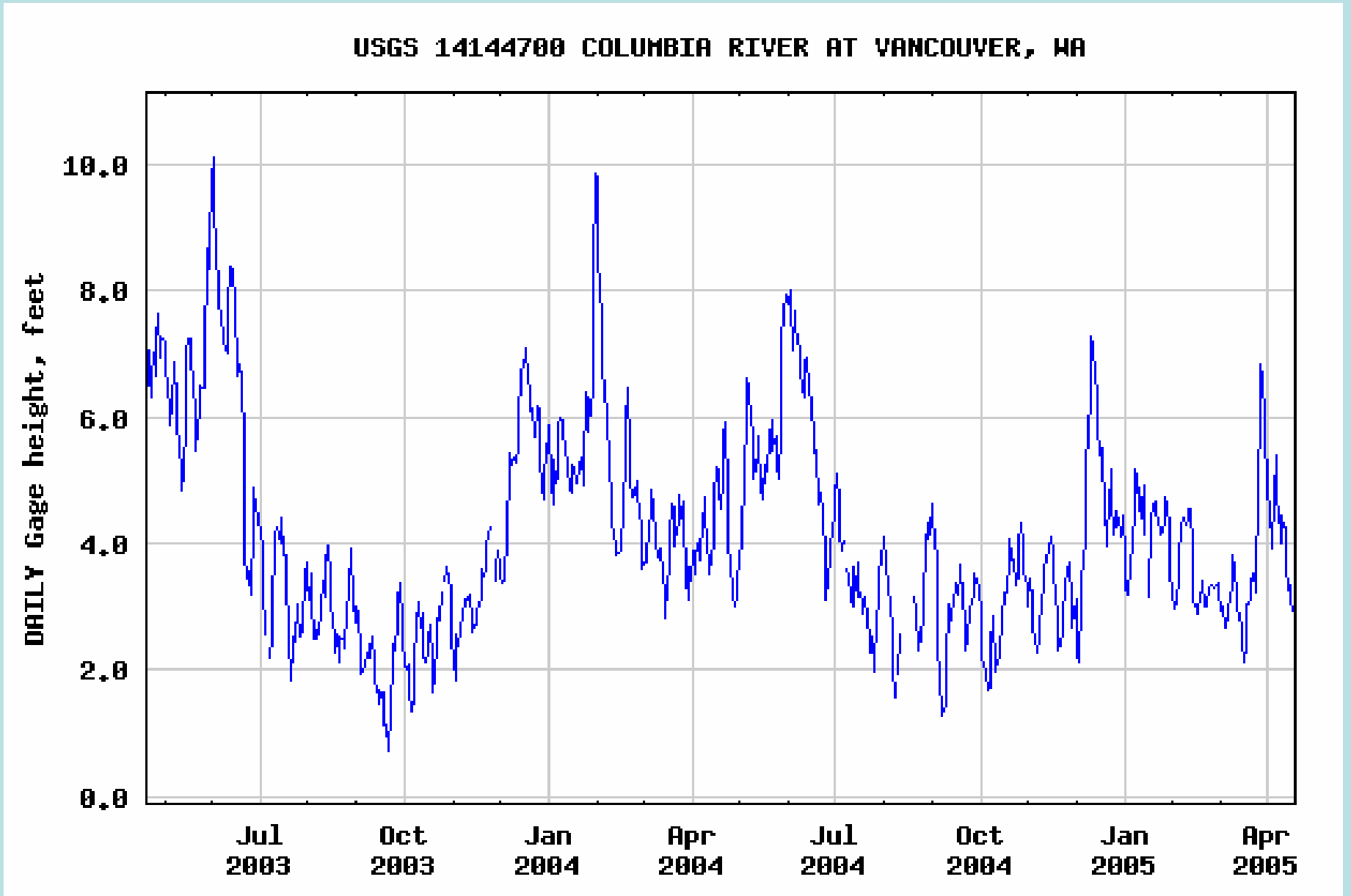
MONTH	AVERAGE STAGE, FEET 1946-68	1973-80
JANUARY	6.65	7.42
FEBRUARY	6.77	6.42
MARCH	6.02	6.35
APRIL	7.56	6.11
MAY	13.20	7.90
JUNE	18.10	7.99
JULY	10.83	4.99
AUGUST	4.64	3.65
SEPTEMBER	3.10	3.28
OCTOBER	3.37	3.21
NOVEMBER	4.68	4.81
DECEMBER	6.09	7.15
AVERAGE	7.58	5.78

HISTORICAL DAILY RIVER STAGES FOR COLUMBIA RIVER AT VANCOUVER (DATA SOURCE: USCE RECORDS)

COOPER CONSULTANTS, INC.	Historical Daily Stage for the Columbia River	5-1

Historic Daily River Stage
Columbia River at Vancouver




USGS 14144700 COLUMBIA RIVER AT VANCOUVER, WA
DAILY Gage height, feet
10.0
8.0
6.0
4.0
2.0
0.0
Jul 2003
Oct 2003
Jan 2004
Apr 2004
Jul 2004
Oct 2004
Jan 2005
Apr 2005

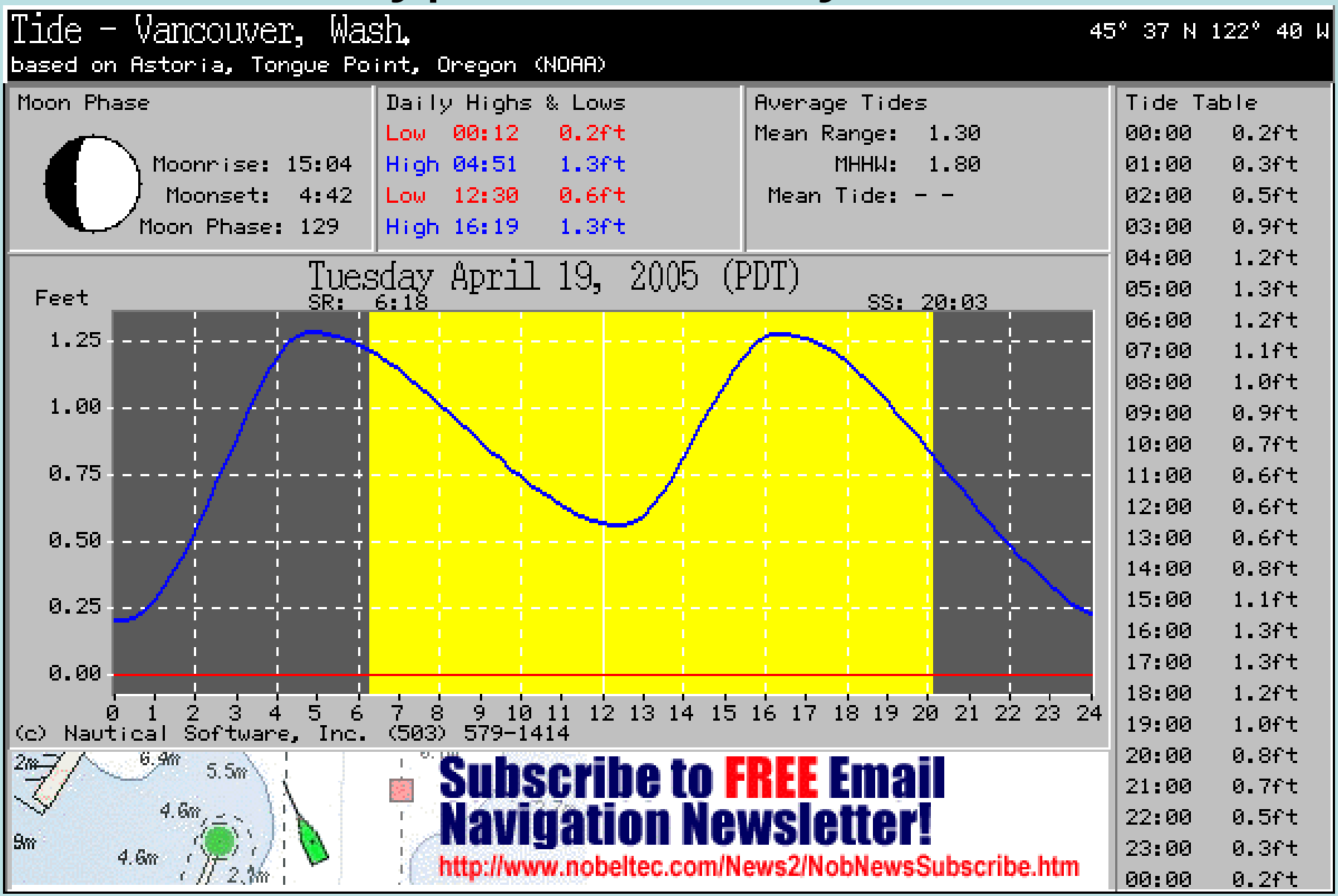
Other Flow Factors

- Tides
- Spill – Flow Augmentation
- Bonneville Dam releases

Tides

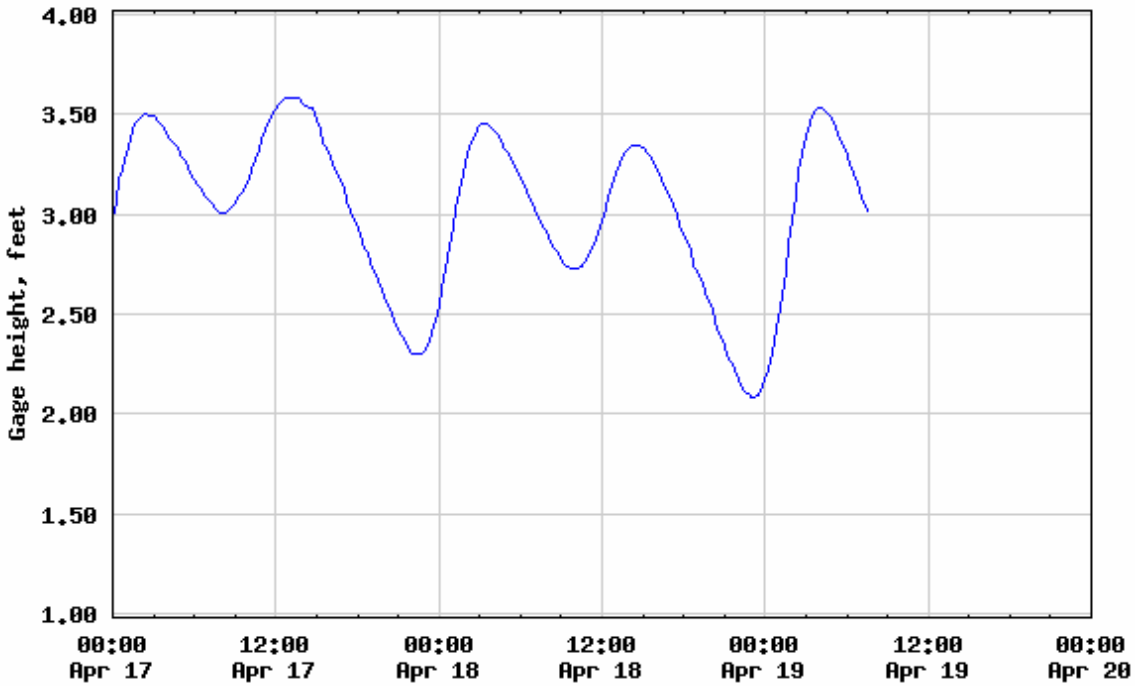
- Remarkably consistent!
- Generally between 1-2 feet
- Tidal influence is less during high Columbia River flows
- Tidal influence is greater during low Columbia River flows

Typical Tidal Cycle

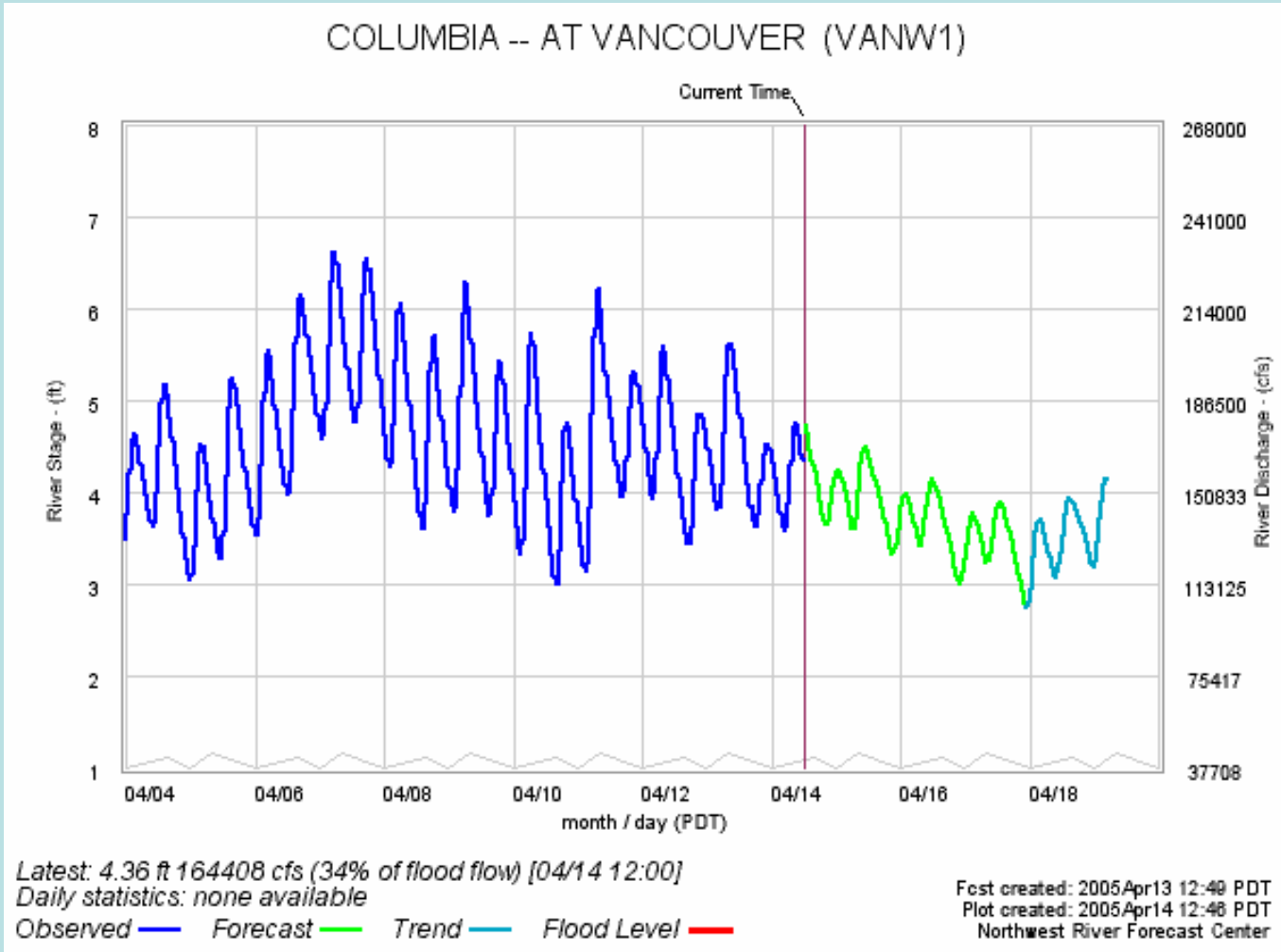


USGS

USGS 14144700 COLUMBIA RIVER AT VANCOUVER, WA



Provisional Data Subject to Revision


COLUMBIA -- AT VANCOUVER (VANW1)
Current Time
River Stage - (ft)
River Discharge - (cfs)
8
7
6
5
4
3
2
1
268000
241000
214000
186500
150833
113125
75417
37708
04/04
04/06
04/08
04/10
04/12
04/14
04/16
04/18
month / day (PDT)
Latest: 4.36 ft 164408 cfs (34% of flood flow) [04/14 12:00]
Daily statistics: none available
Observed
Forecast
Trend
Flood Level
Fcst created: 2005Apr13 12:49 PDT
Plot created: 2005Apr14 12:48 PDT
Northwest River Forecast Center

Spill - 2004 Spill Starts

Location	Date			Spill		
BON	2/28/2004	135.15	128.75	0	75.26	12.67
BON	2/29/2004	126.48	120.08	0	75.04	11.85
BON	3/1/2004	141.48	133.19	1.68	74.64	12.73
BON	3/2/2004	142.32	125.8	9.93	75.25	12.75
BON	3/3/2004	171.85	115.37	50.1	75.85	13.54
BON	3/4/2004	155.29	98.59	50.28	75.75	12.56
BON	3/5/2004	166.88	110.5	49.99	75.22	13.22
BON	3/6/2004	169.91	121.72	41.98	75.75	14.18
BON	3/7/2004	121.25	113.13	2.12	74.43	12.35
BON	3/8/2004	123.26	115.18	2.07	74.9	11.8
BON	3/9/2004	124.11	115.99	2.12	75.06	11.96
BON	3/10/2004	135.5	127.35	2.22	75.49	12.53

2004 Spill - Continues

Location	Date			Spill		
BON	4/9/2004	151.26	142.44	2.42	74.7	14.02
BON	4/10/2004	150.85	142.05	2.41	75.75	13.43
BON	4/11/2004	140.81	132.01	2.4	74.96	12.63
BON	4/12/2004	154.49	133.16	14.92	74.46	13.13
BON	4/13/2004	176.6	117.94	50.52	75.92	13.97
BON	4/14/2004	182.58	120.86	50.5	74.83	14.46
BON	4/15/2004	201.27	138.52	51.32	74.76	15.82
BON	4/16/2004	215.68	141.71	62.55	75.03	16.81
BON	4/17/2004	216.02	128.85	75.77	75.29	16.82
BON	4/18/2004	177.72	90.65	75.7	75.17	14.57
BON	4/19/2004	198.06	111.6	75.08	74.72	15.38
BON	4/20/2004	194.44	108.13	74.92	74.77	15.55
BON	4/21/2004	236.76	139.79	85.57	75.57	17.9
BON	4/22/2004	210.81	105.47	93.92	74.49	16.81
BON	4/23/2004	184.52	78.97	94.15	75.48	14.47

2004 Spill Ends

Location	Date			Spill		
BON	8/27/2004	184.25	61.03	112.25	75.41	14.4
BON	8/28/2004	171.51	55.92	104.21	75.23	13.89
BON	8/29/2004	160.67	52.06	97.21	75.3	13.07
BON	8/30/2004	189.55	80.12	98.04	75.43	14.85
BON	8/31/2004	182.34	75.93	97.04	75.64	14.76
BON	9/1/2004	142.97	133.93	2.64	75.46	13.66
BON	9/2/2004	154.78	146.15	2.23	75.75	14.31
BON	9/3/2004	128.42	119.46	2.42	76.38	12.47

Bonneville Dam Releases

- Unable to acquire dam release schedule or determine changes in Columbia River flow levels of stage height due to dam releases for power generation.

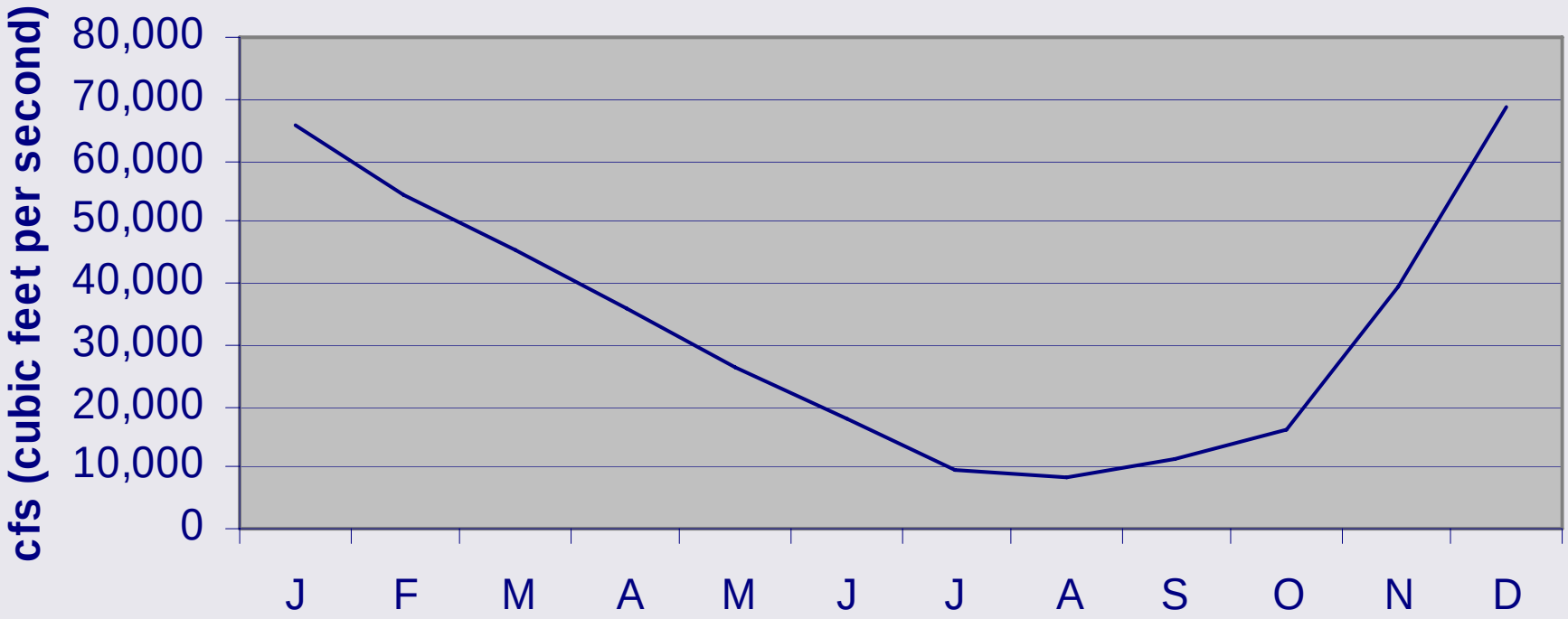
Other Flow Factors

- The accumulated volume of water for the past six years, including 2005, is the lowest on record. (Suzanne Cooper, BPA program analyst)
- Irrigation - (6 % of Columbia River flow (measured at mouth) is diverted for Irrigation. (9% if measured at The Dalles)).
- Climate change

Willamette River

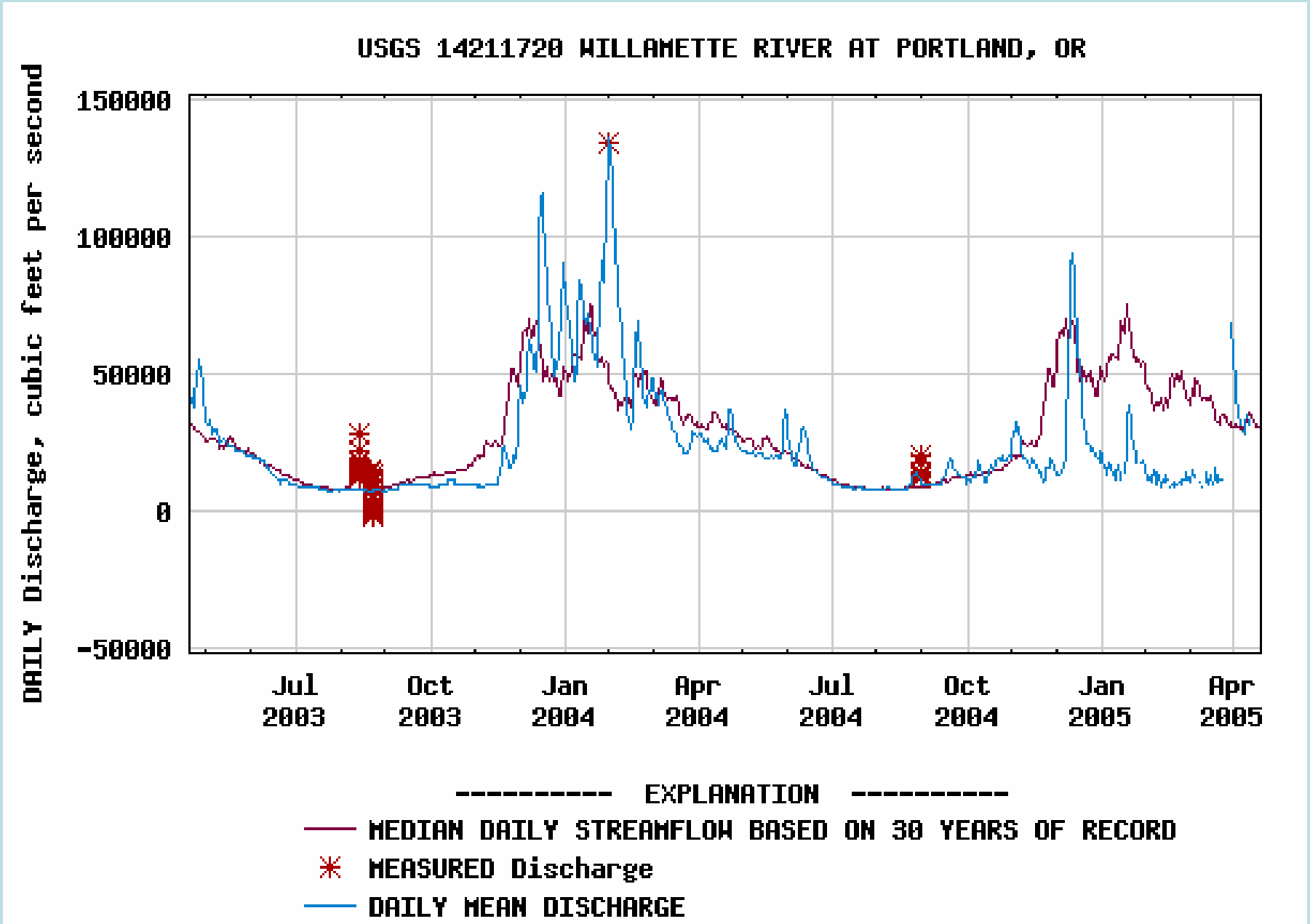
- 13th largest river by volume in US
- Drains 11,500 square miles
- Average flow is 32,000 cubic feet per second (1996 peak flow – 460,000 cfs)
- System has 13 US Army Corps dams and others that produce hydropower, and regulate approximately 27% of the basin
- Primarily rain driven system
- Tidally influenced to Oregon City

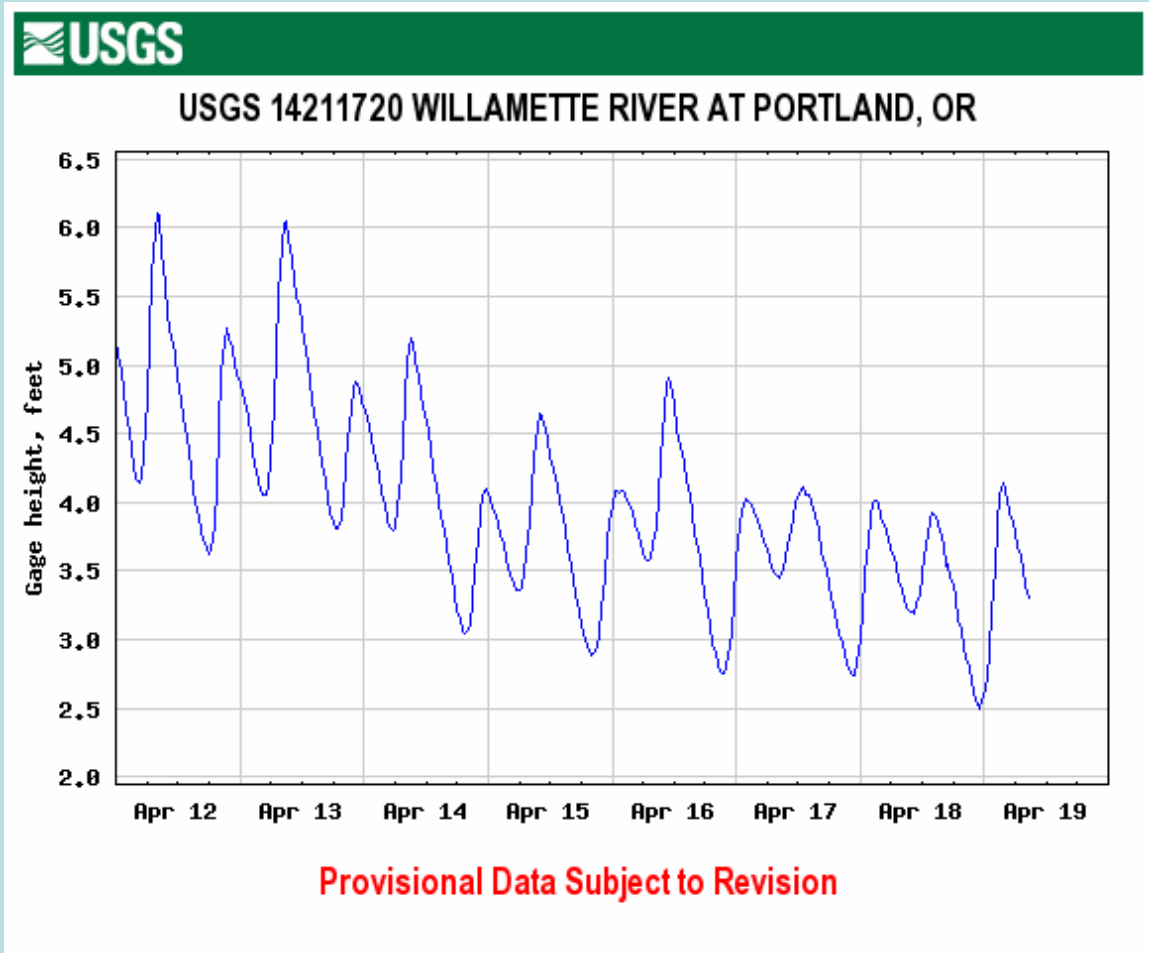
Willamette River Mean Monthly Streamflow (1972-2002)



Calendar Year Streamflow Statistics for Oregon
USGS 14211720
WILLAMETTE RIVER AT PORTLAND, OR

Year	Annual mean streamflow, in ft3/s
1973	33,390
1974	43,070
1975	39,790
1976	28,380
1977	27,289
1978	25,069
1979	29,820
1980	31,720
1981	32,620
1982	41,730
1983	43,110
1984	41,670
1985	23,500
1986	32,379
1987	24,190
1988	29,080
1989	26,650
1990	30,220
1991	29,480
1992	21,170
1993	32,360
1996	57,490
1997	41,750
1998	39,920
1999	45,300
2000	28,410
2001	22,480
2002	28,340


USGS 14211720 WILLAMETTE RIVER AT PORTLAND, OR
DAILY Discharge, cubic feet per second
150000
100000
50000
0
-50000
Jul 2003
Oct 2003
Jan 2004
Apr 2004
Jul 2004
Oct 2004
Jan 2005
Apr 2005
EXPLANATION
MEDIAN DAILY STREAMFLOW BASED ON 30 YEARS OF RECORD
MEASURED Discharge
DAILY MEAN DISCHARGE


USGS
USGS 14211720 WILLAMETTE RIVER AT PORTLAND, OR
Gage height, feet
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
Apr 12
Apr 13
Apr 14
Apr 15
Apr 16
Apr 17
Apr 18
Apr 19
Provisional Data Subject to Revision

Vancouver Lake Implications (?)

- Overall flow conditions have not changed much since 1969 – or since installation of the flushing channel.
- Columbia River flow information is not new. Changes in flow timing and size are well known.

Vancouver Lake Implications (?)

- Columbia River flows and stage levels are highly complex and depend on a number of factors
  - Hydropower system management
  - Snowpack, weather, climate
  - Fish management issues (spill, flow augmentation)
  - Tides
  - Irrigation and other water withdrawals
  - Dam releases
  - Tributaries flow

Vancouver Lake Implications (?)

- Columbia River's impact on Vancouver Lake hard to determine without knowing
  - Annual volume from Flushing Channel
  - Annual volume from Lake River
  - Willamette River implications - ???