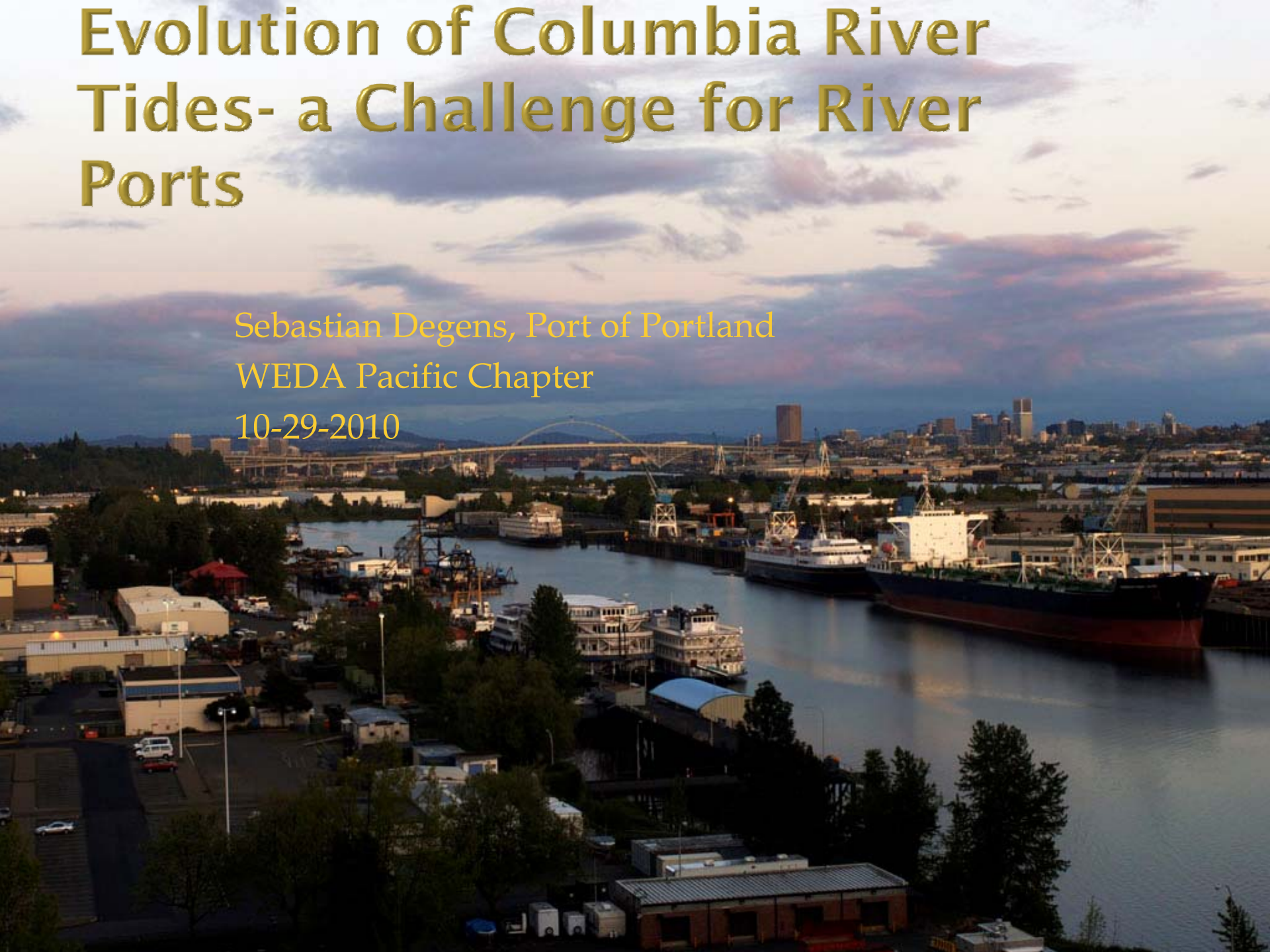
Evolution of Columbia River Tides- a Challenge for River Ports

Sebastian Degens, Port of Portland

WEDA Pacific Chapter

10-29-2010



Columbia River Forecast

Projected Trip Results

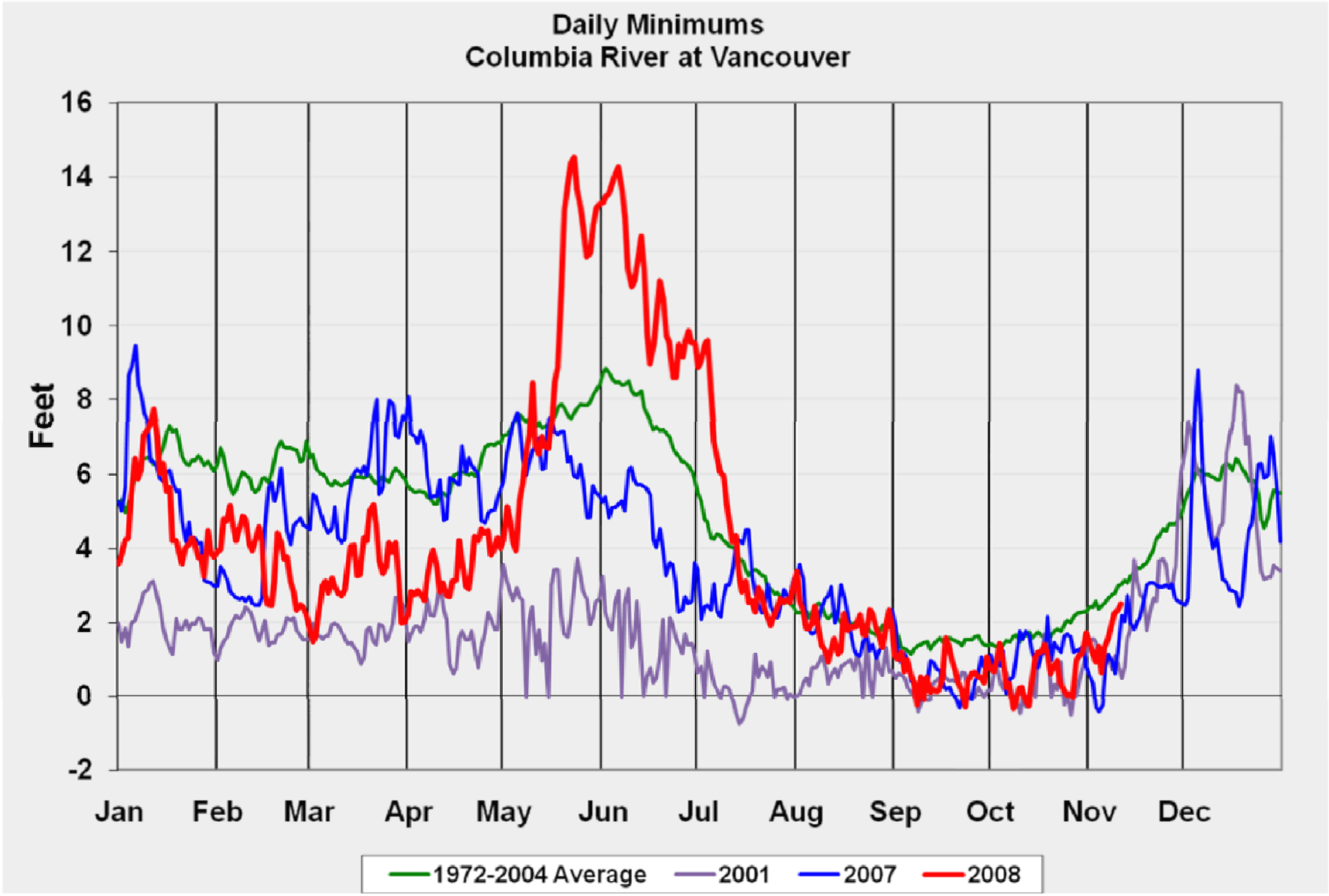
Total Time:	7 hr. 7 min.
Minimum Underkeel Clearance:	2.3 ft.
Minimum Depth:	42.3 ft.

Note: Outbound results calculated from Vancouver

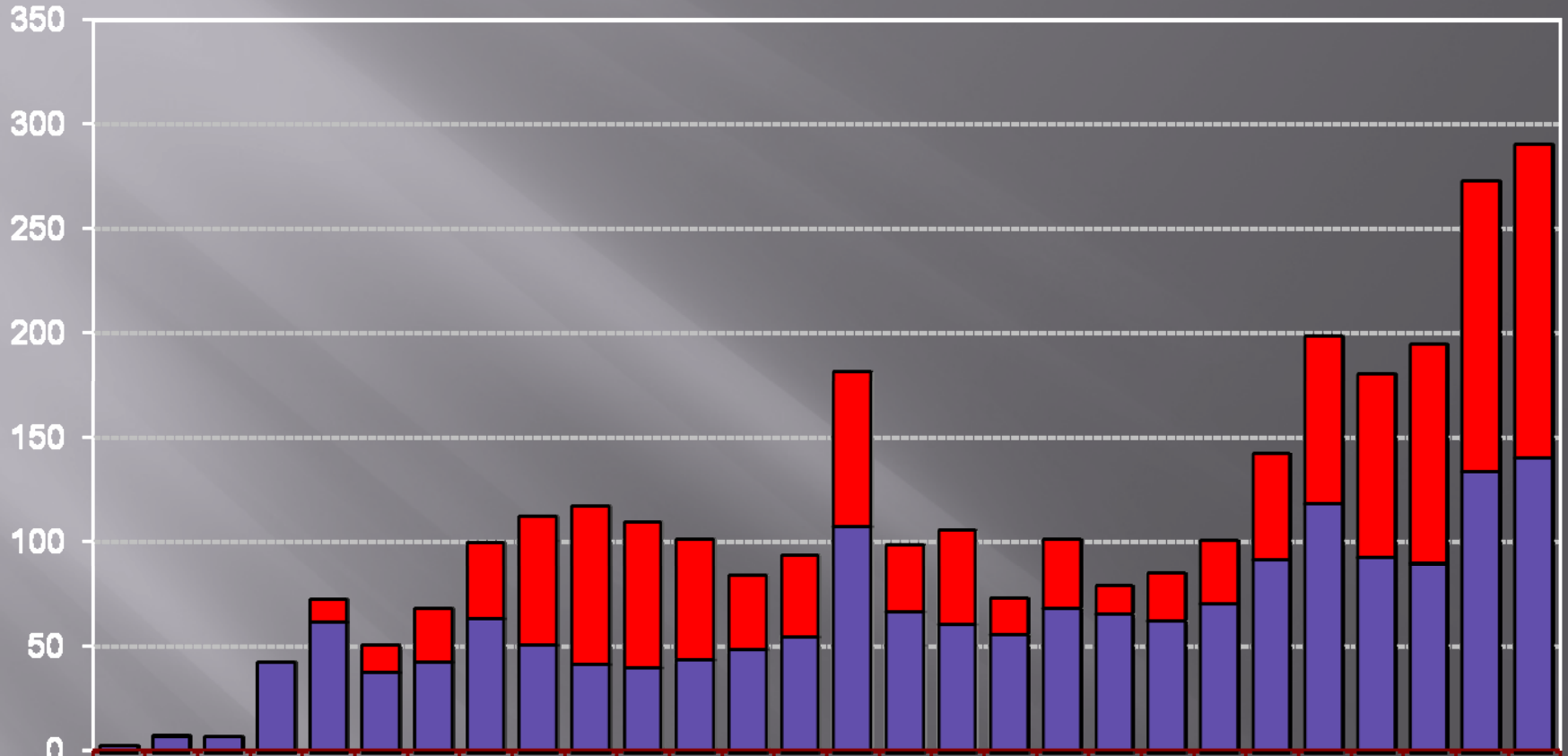
Trip Parameters

- U.S. / Metric
- Date: 10/12/2010
- Time: 2:00 p.m.
- Destination: Outbound
- Draft: 40 feet
- Speed: 13 knots
- Submit

Forecast Last Updated On: 10/11/2010


Daily Minimums
Columbia River at Vancouver
Feet
16
14
12
10
8
6
4
2
0
-2
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
1972-2004 Average
2001
2007
2008

Columbia River Vessel Transits With Drafts of 39 feet or More 1981 - 2008



	'81	'82	'83	'84	'85	'86	'87	'88	'89	'90	'91	'92	'93	'94	'95	'96	'97	'98	'99	'00	'01	'02	'03	'04	'05	'06	'07	'08
>= 40 ft	0	1	0	0	11	13	26	36	62	76	70	58	36	39	74	32	45	18	33	14	23	30	51	80	88	105	139	150
39 ft	2	6	6	42	61	37	42	63	50	41	39	43	48	54	107	66	60	55	68	65	62	70	91	118	92	89	133	140

Source: Port of Portland from data provided by the Columbia River Pilots

Columbia River Forecast

Projected Trip Results

Total Time:	7 hr. 7 min.
Minimum Underkeel Clearance:	2.3 ft.
Minimum Depth:	42.3 ft.

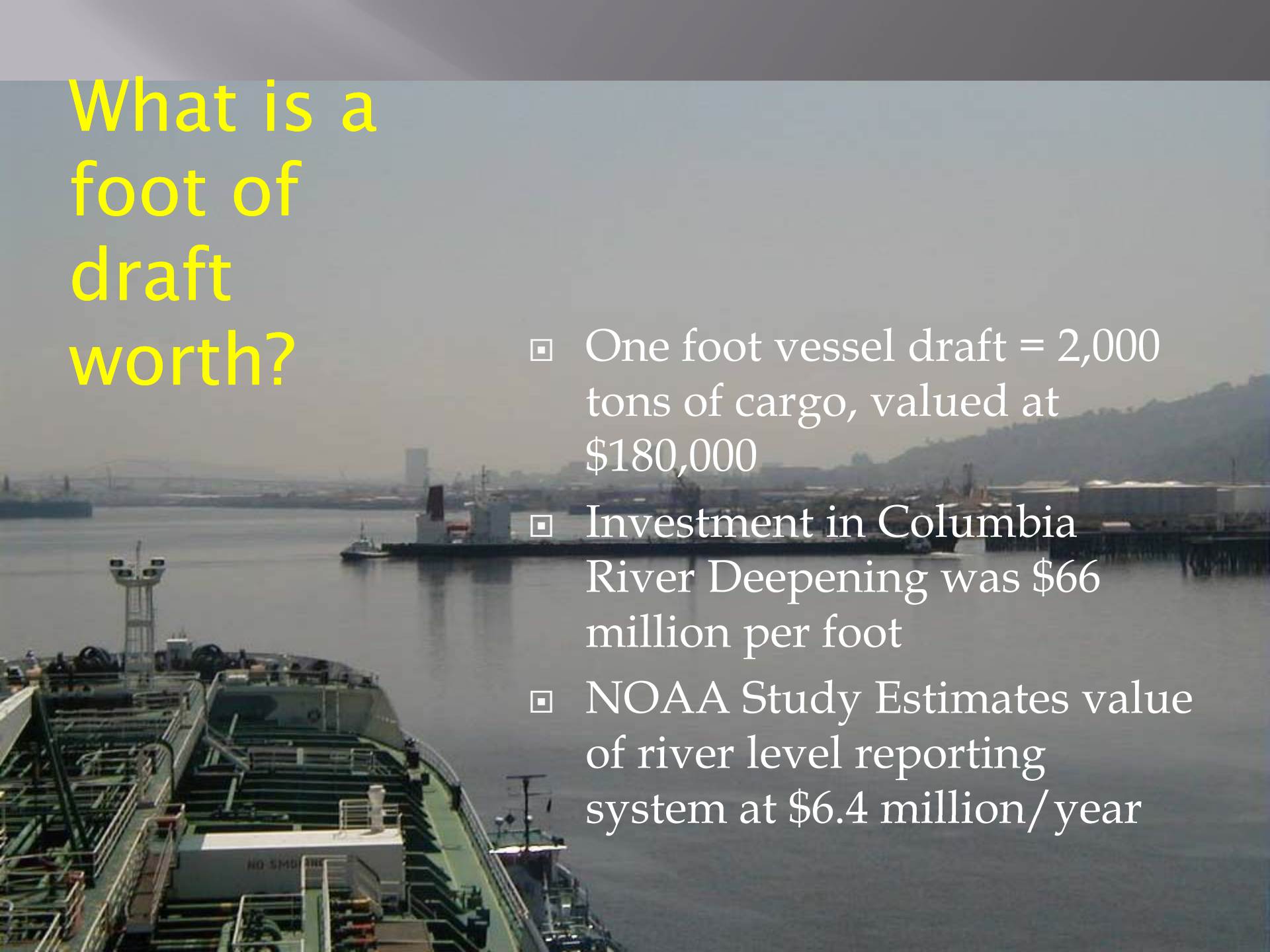
Note: Outbound results calculated from Vancouver

Trip Parameters

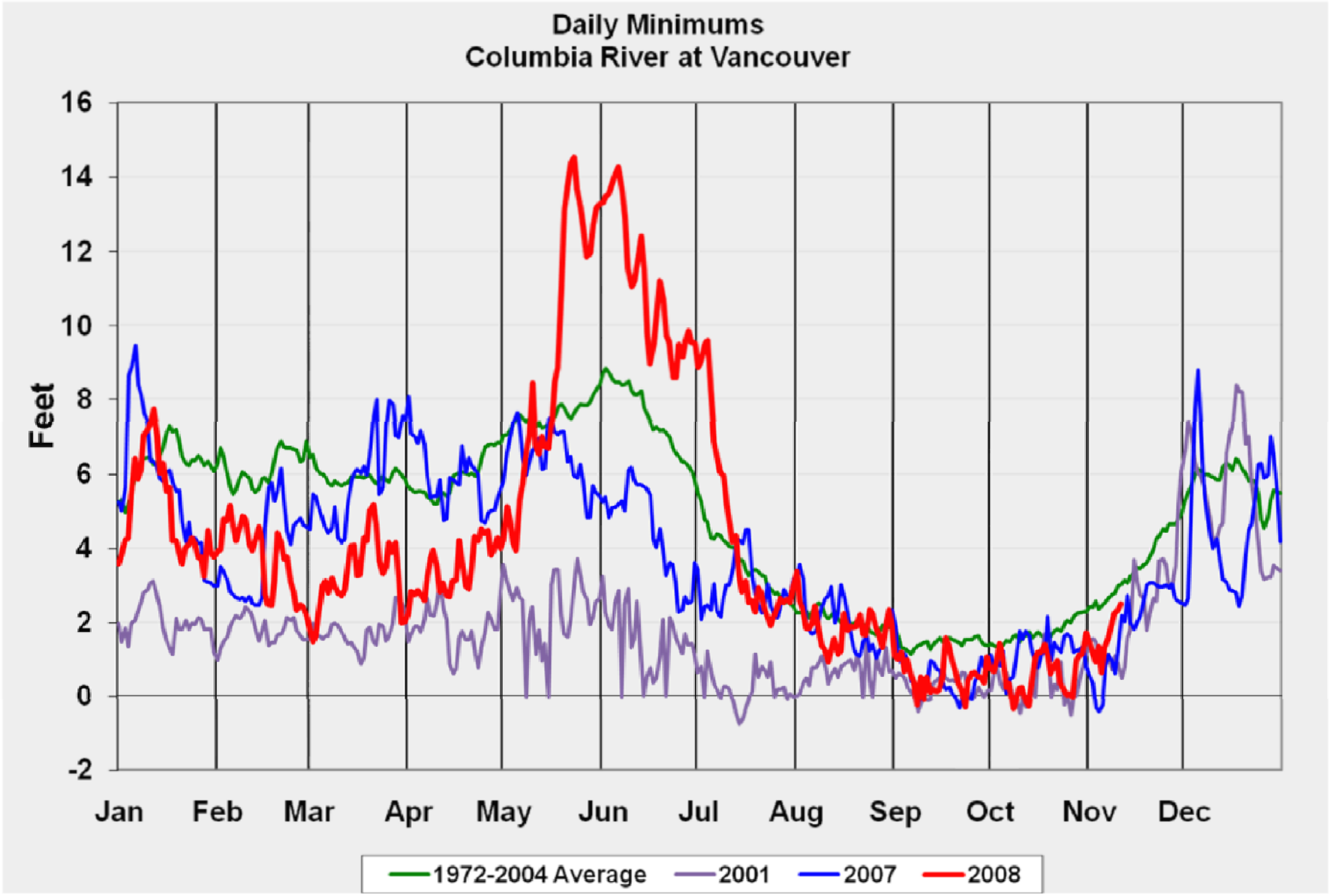
- U.S. / Metric
- Date: 10/12/2010
- Time: 2:00 p.m.
- Destination: Outbound
- Draft: 40 feet
- Speed: 13 knots
- Submit

Forecast Last Updated On: 10/11/2010

What is a foot of draft worth?



- One foot vessel draft = 2,000 tons of cargo, valued at $180,000
- Investment in Columbia River Deepening was $66 million per foot
- NOAA Study Estimates value of river level reporting system at $6.4 million/year

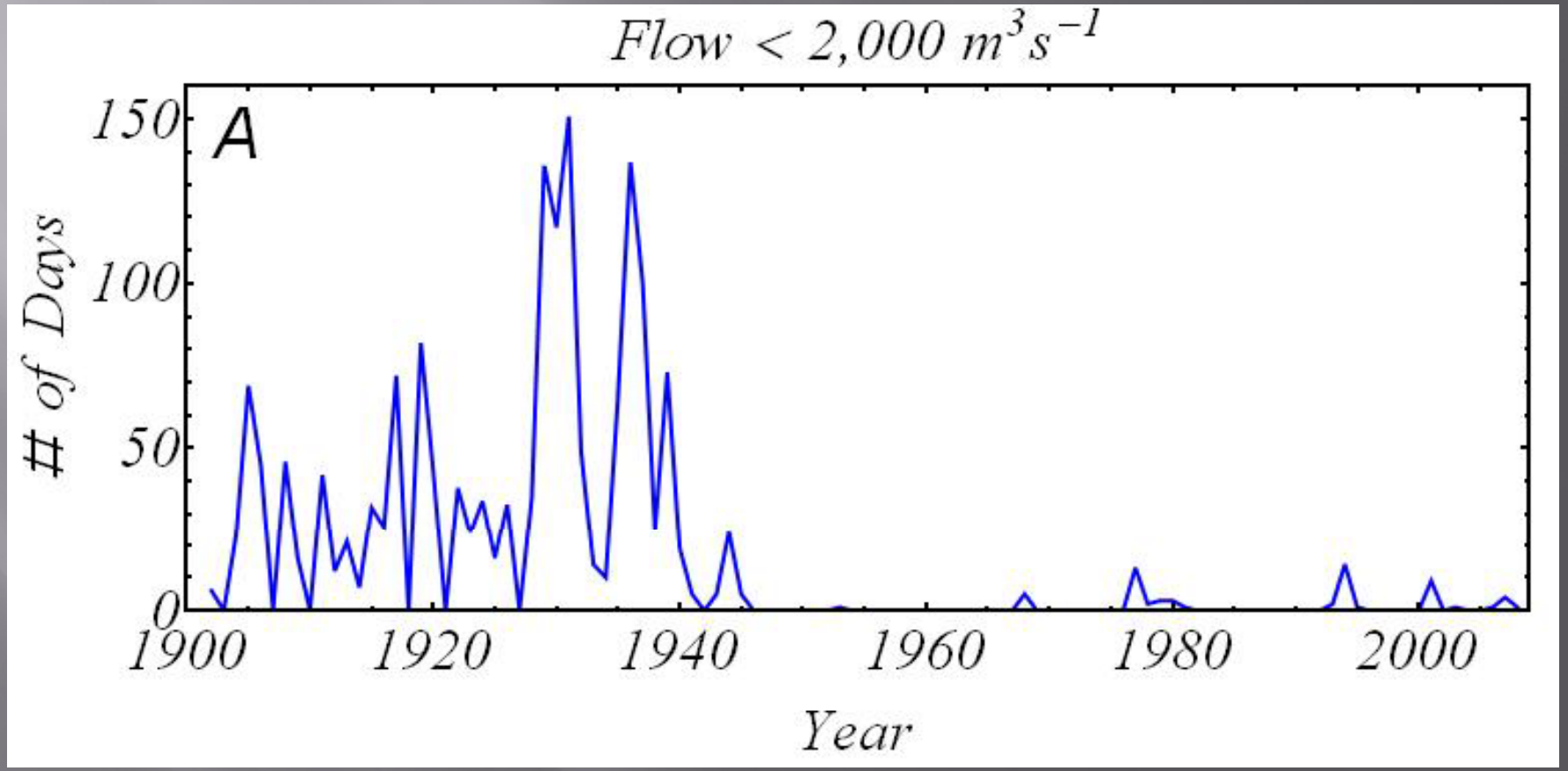

Daily Minimums
Columbia River at Vancouver
Feet
16
14
12
10
8
6
4
2
0
-2
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
1972-2004 Average
2001
2007
2008

The problem statement

- Regardless of how good the water year is, we always seem to be in an alarm mode every summer. There is never enough water.

We are not dreaming

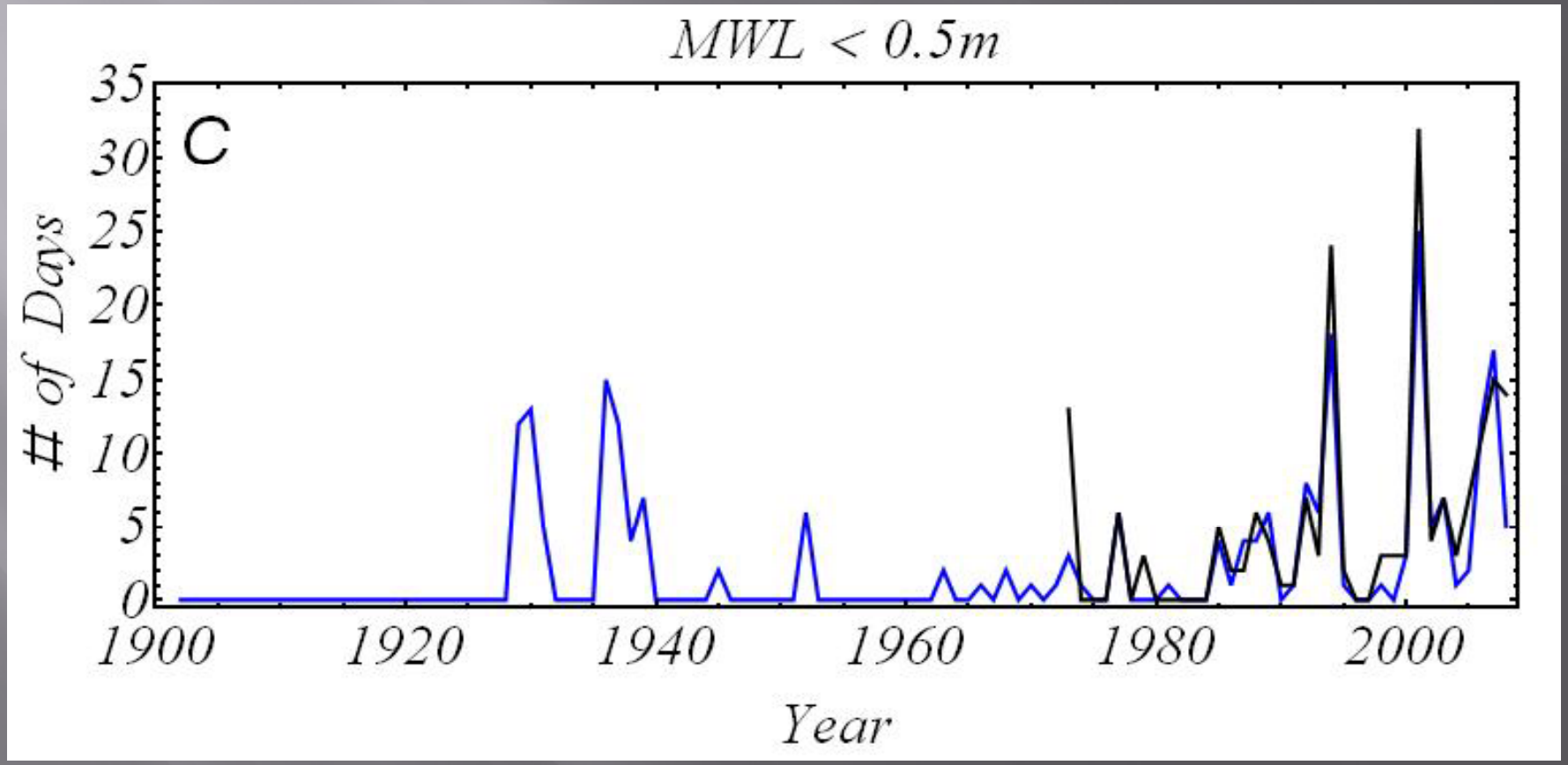
Number of Low-Flow Days, 1902-2008



Source: Jay et al, 2010

Low water days are increasing

Number of Days, MWL <0.5m on CRD 1902-2008



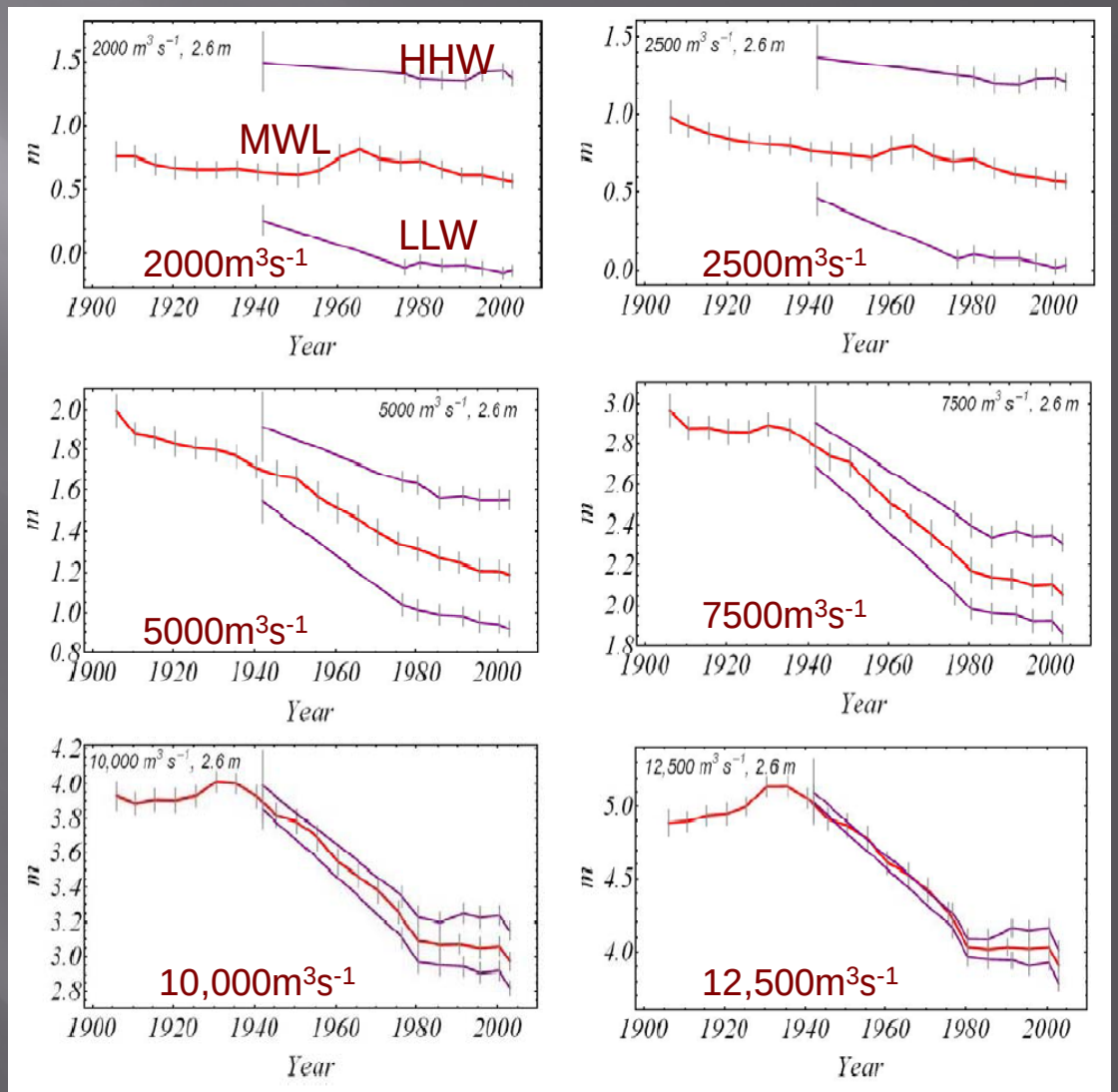
Source: Jay et al, 2010

Water Levels Down, Range Increasing in Tidal River –

- Water levels are lower for any given flow
  - LLW water has dropped more than HHW
  - Tidal range has increased
- Lower values of LLW in fall are a threat to navigation
  - Down by 0.3-0.5m
- Lower high of HHW in the spring inundate less SWHA
  - Down by 1-1.5m
  - But effect of tides is smaller than that of reduced river flow

Source: Jay et al, 2010

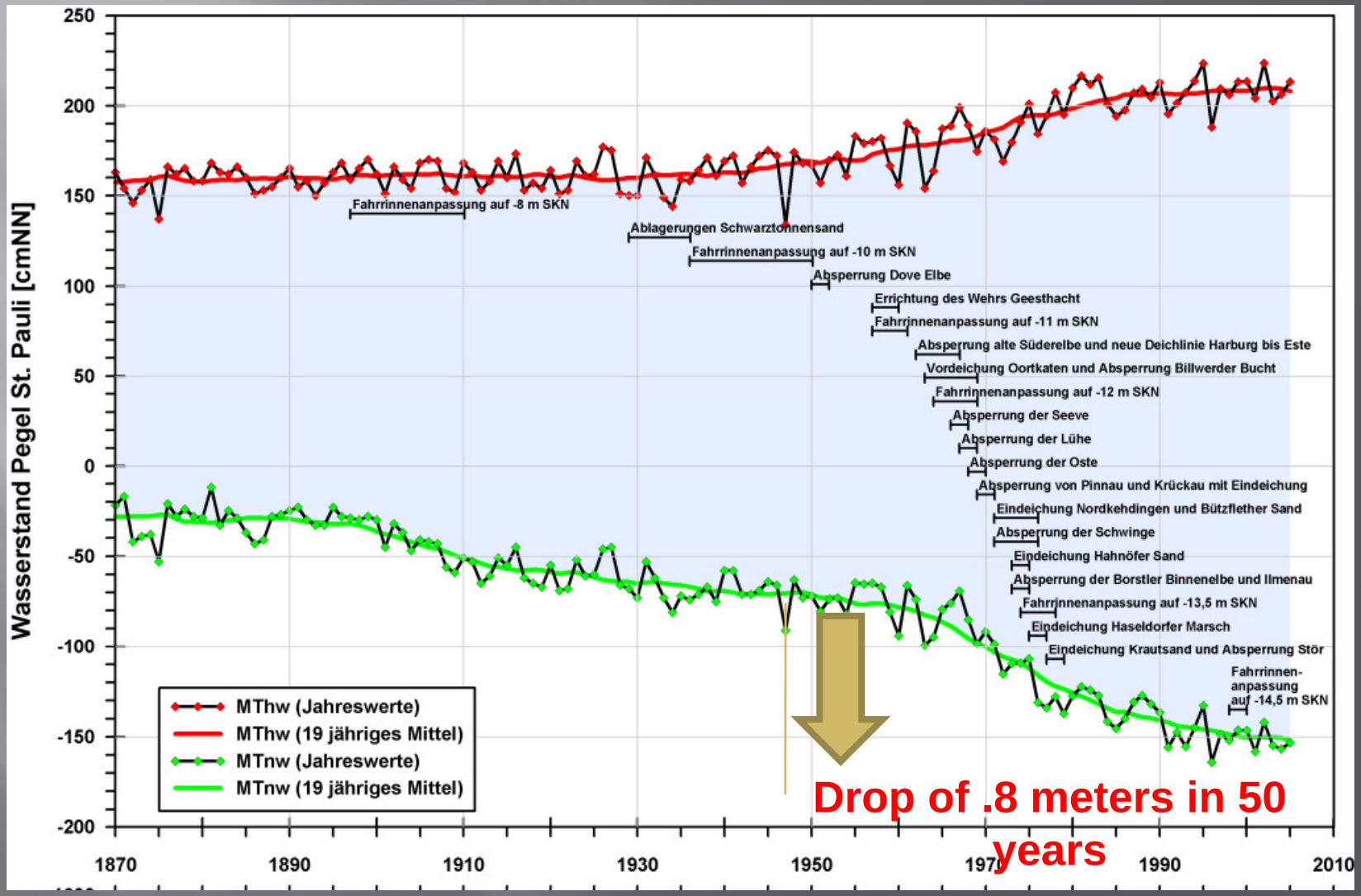
Changes in tides at Vancouver, 1902-2008 for Six Different Flow Levels



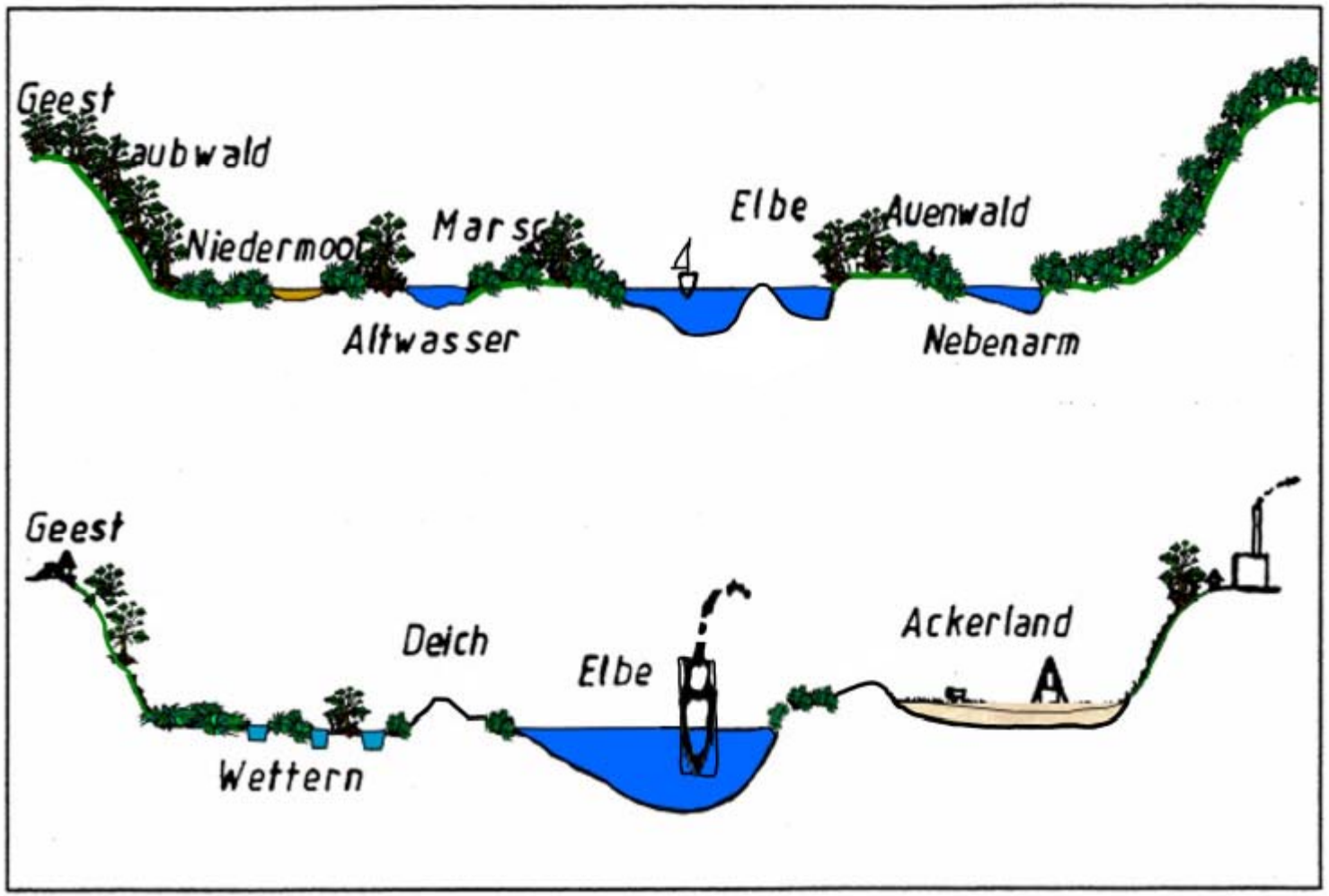
Other Rivers, Similar Problems

- Delaware (DiLorenzo et al, 1993
  - Tide amplification, phase shift
- Elbe, Ems, Weser (Jensen et al, 2003)
  - Tidal range, lower tides, sediment management
- Thames (Amin, 1983)
  - Tidal range
- Sheldt, Humber, Loire (www.TIDE-project.eu, 2010)
  - Tidal range, sediment management

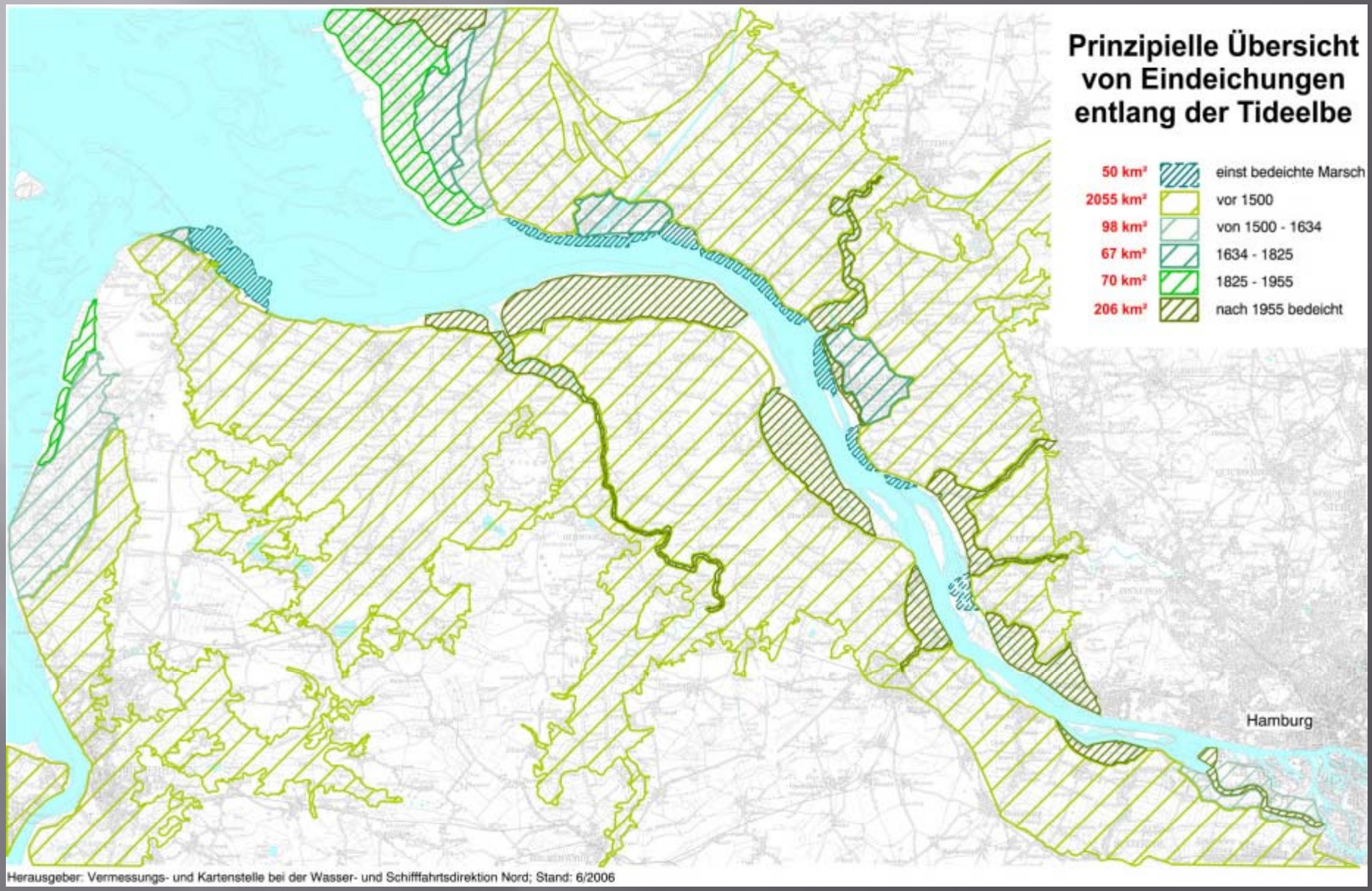
Tidal shift in Hamburg



Source: HPA, 2006; BAW 2009



Source: HPA, 2006



Source: HPA, 2006

So what might be going on on the Columbia?

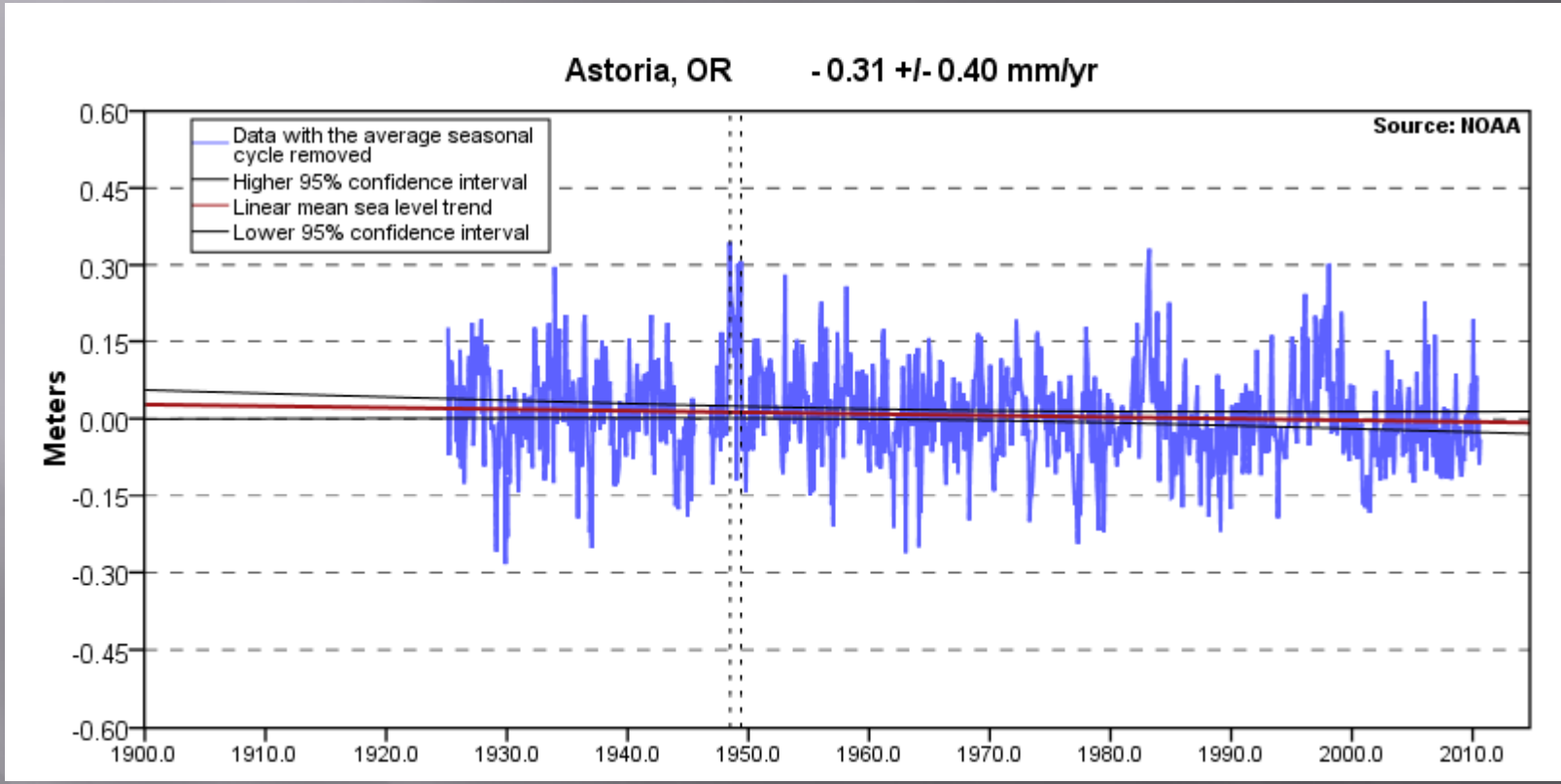
Factors that would decrease low water events

- Increase in ocean tidal amplitude
- Flow Regulation
- Sea Level Rise

Factors that would increase low water events

- Decrease in the roughness of the channel
- Channelization/ deeper channel
- Bed degradation
- Decreases in river flow

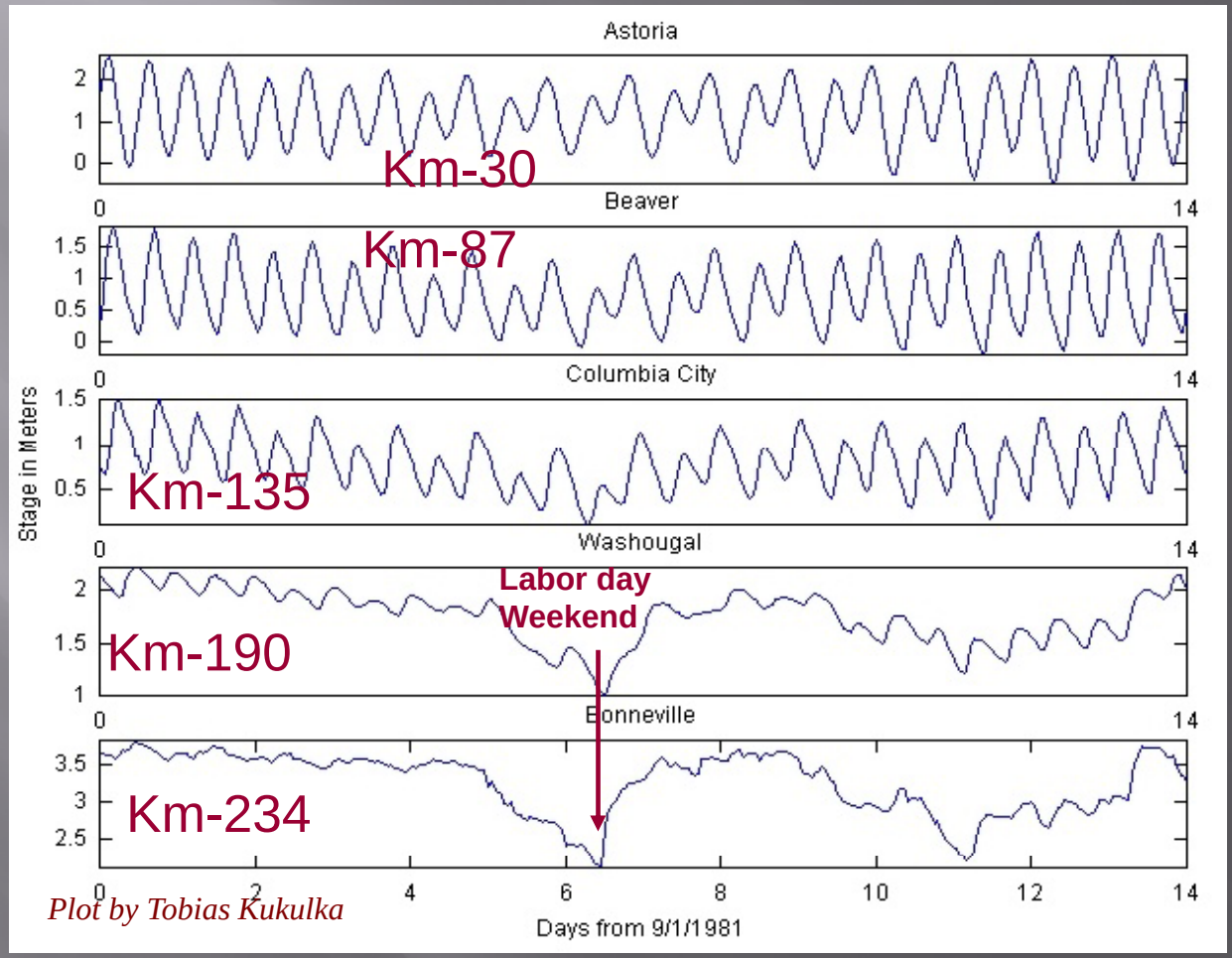
Mean Sea Level Trend Astoria, Oregon



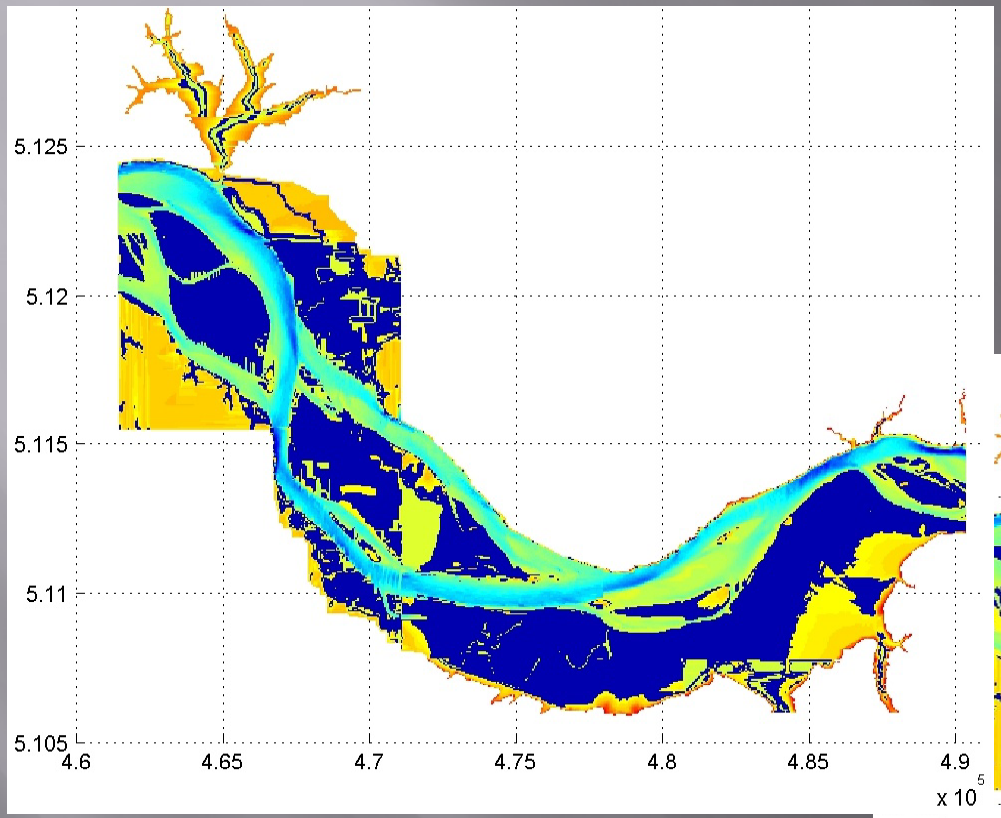
The mean sea level trend is -0.31 millimeters/year with a 95% confidence interval of +/- 0.40 mm/yr based on monthly mean sea level data from 1925 to 2006 which is equivalent to a change of -.10 feet in 100 years

Flow Regulation

CR tides, from the ocean to Bonneville dam



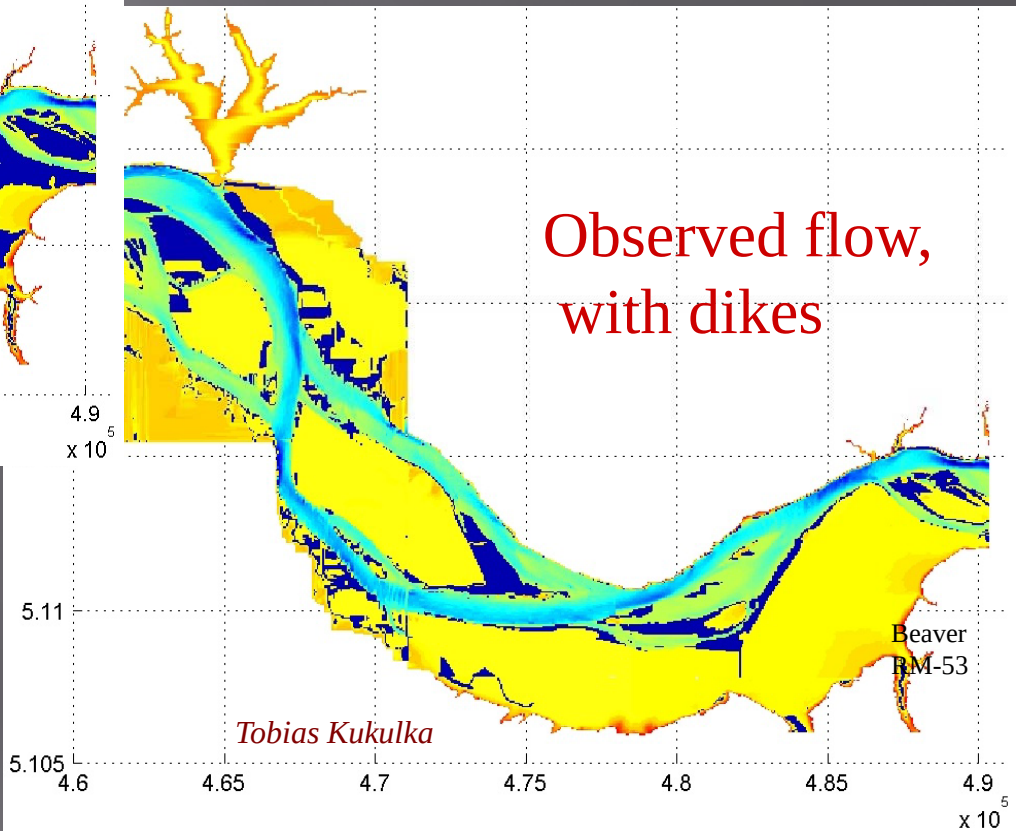
Impact of Diking



1974 Inundation

Blue = floodplain SWHA

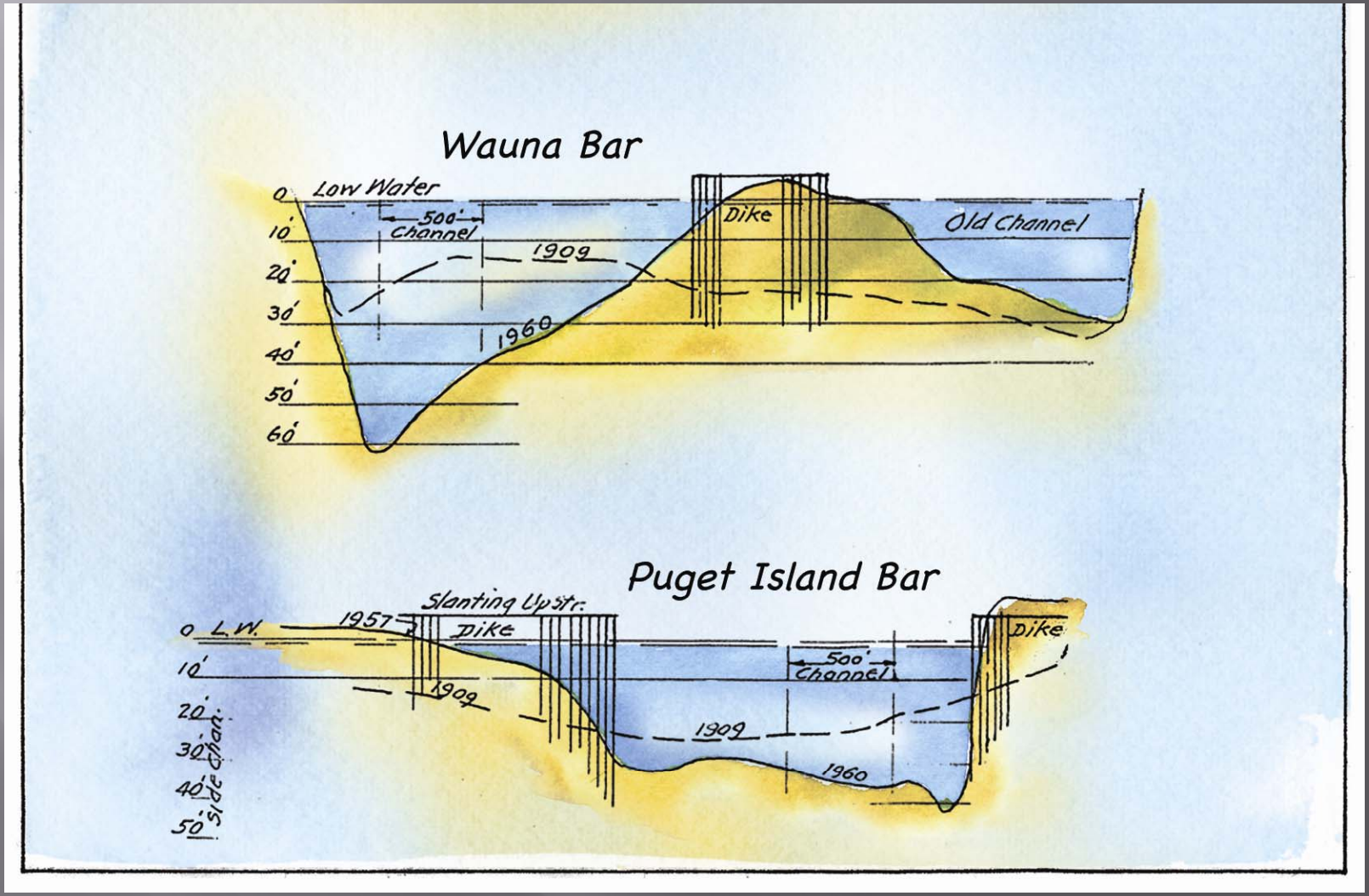
Yellow = dry area

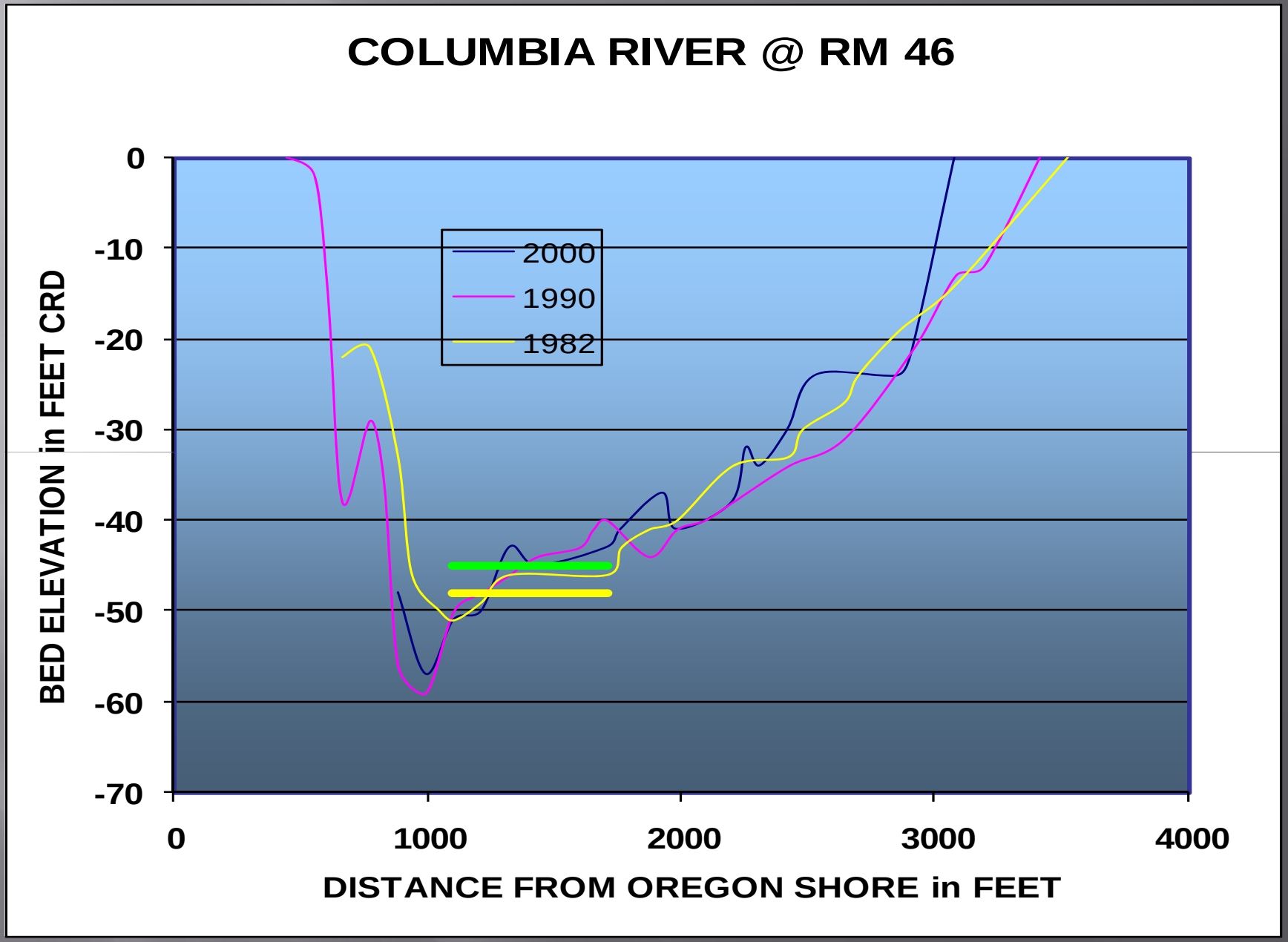


Source: Kukulka, 2003


Coast Range @ Westport RM 46

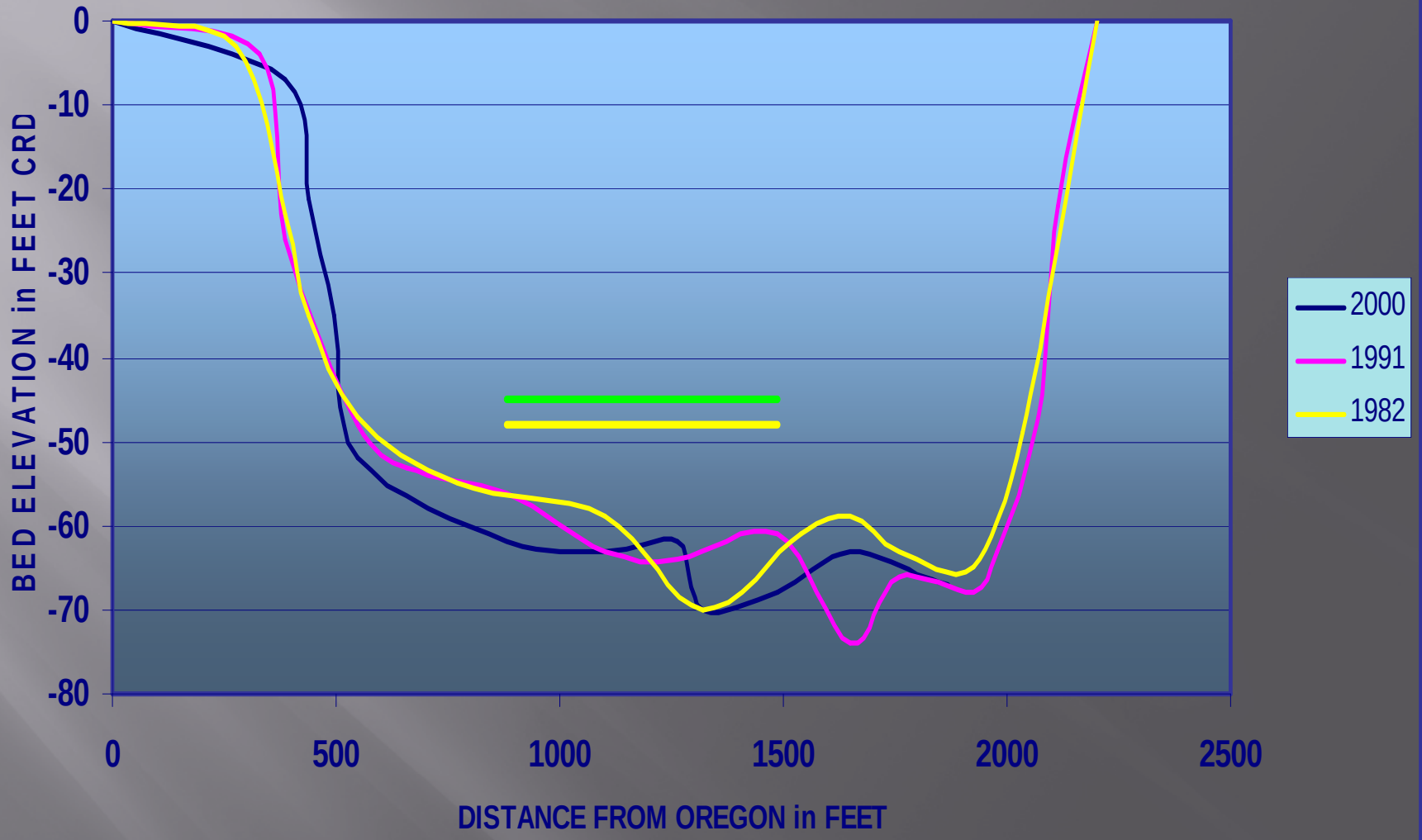
Channelization & reduced friction

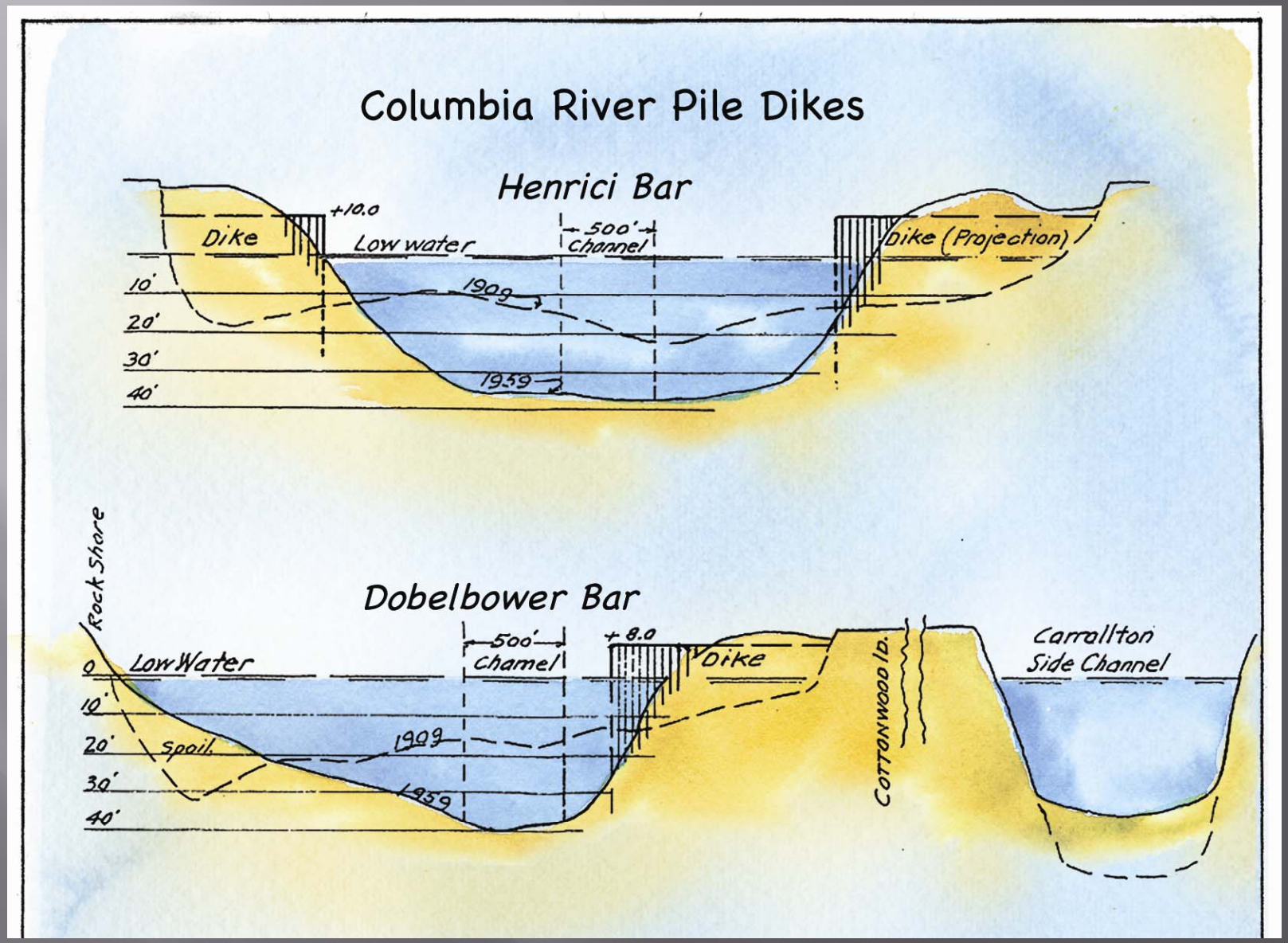


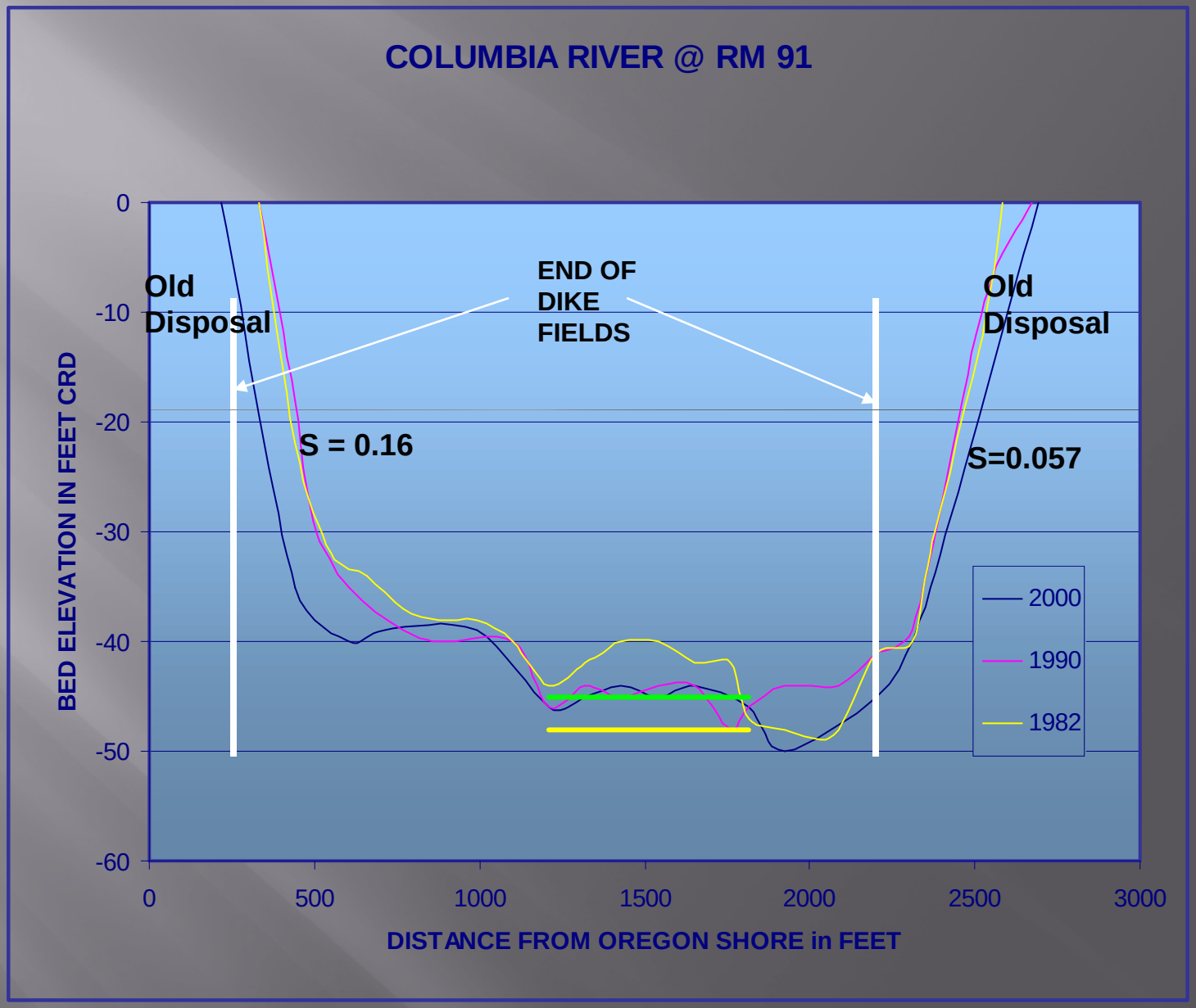


Source: ACOE, 2001

COLUMBIA RIVER at RM 53




Columbia River Pile Dikes
Henrici Bar
+10.0
Dike
Low water
500'
Channel
Dike (Projection)
10'
20'
30'
40'
1909
1959
Dobelbower Bar
Rock Shore
0
Low Water
500'
Channel
+8.0
Dike
Cottonwood Id.
Carrollton
Side Channel
10'
20'
Spoil
30'
40'
1909
1959


COLUMBIA RIVER @ RM 91
Old Disposal
END OF DIKE FIELDS
Old Disposal
S = 0.16
S=0.057
2000
1990
1982
BED ELEVATION IN FEET CRD
0
-10
-20
-30
-40
-50
-60
0
500
1000
1500
2000
2500
3000
DISTANCE FROM OREGON SHORE in FEET

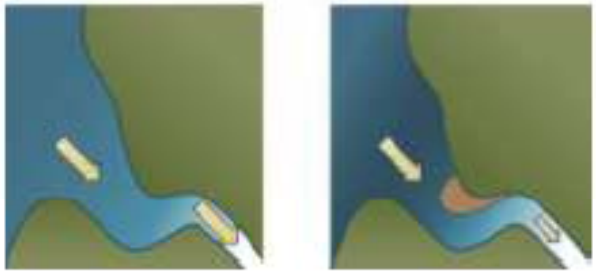
What can we conclude?

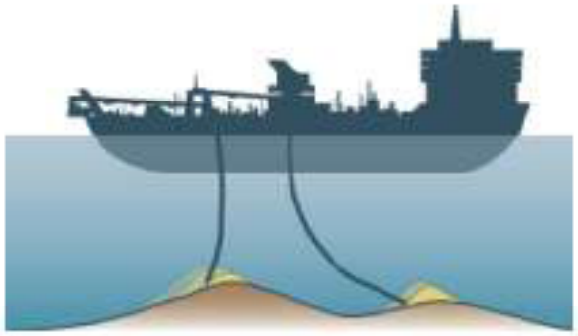
- Tide change is real & problematic for Deep Draft ports on the Columbia River
- Appears to be common to river ports, though geography and specific impacts vary
- Lowest tides associated with flow regulation, tide shift linked to man-made changes to channel


Where might we go from here?

Sustainable River Development- German style

Three Cornerstones for a future action plan:





1. **Attenuation of the Tidal Energy through River Engineering in the Mouth of the Estuary,**

2. **More Room for the River (Tidal Volume) between Glückstadt and Geesthacht**

3. **Optimisation of the Sediment-management considering the whole System of the Elbe**

Source: HPA, 2009

Questions?

Lavros heading out RM 12

Actions to deal with Low Water

- Disseminating the information for use within the maritime industry and other stakeholders in a timely manner

- Advancing bathymetric surveys
- Increasing the frequency of surveys
- Advancing the timing of dredging, obstruction removal & other berth maintenance
- Advancing the timing of dredging, obstruction removal & other berth maintenance
- Coordinating to assure the availability of dredge capability