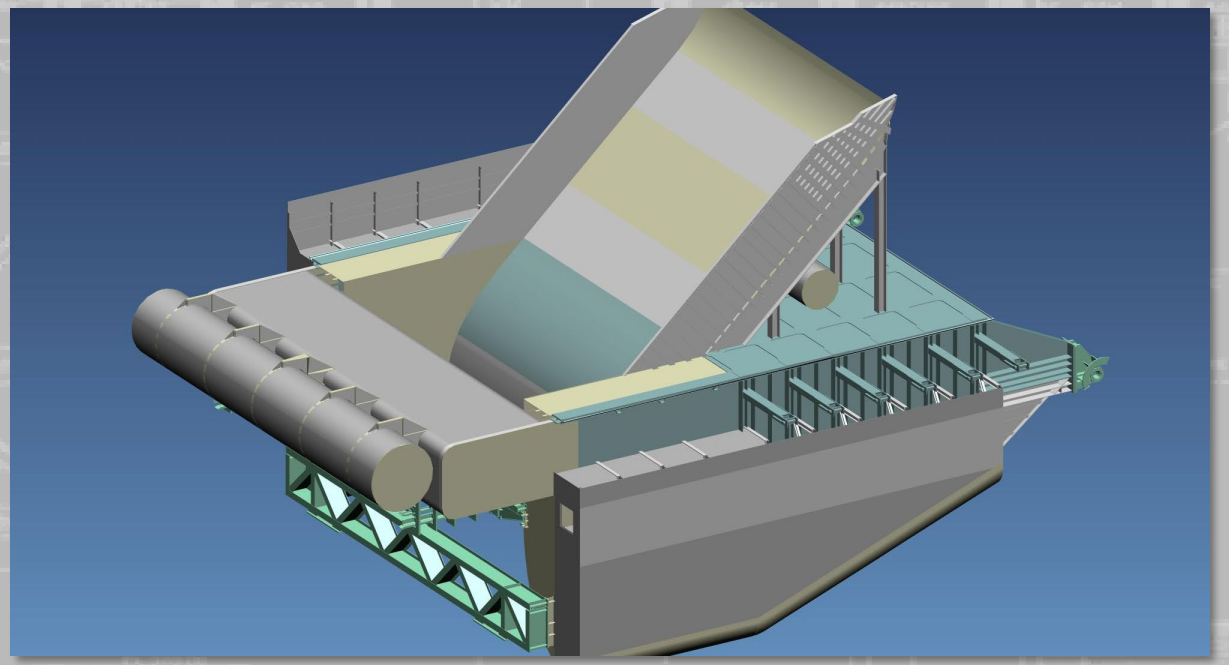
SNAKE RIVER SALMON AND FISH PASSAGE

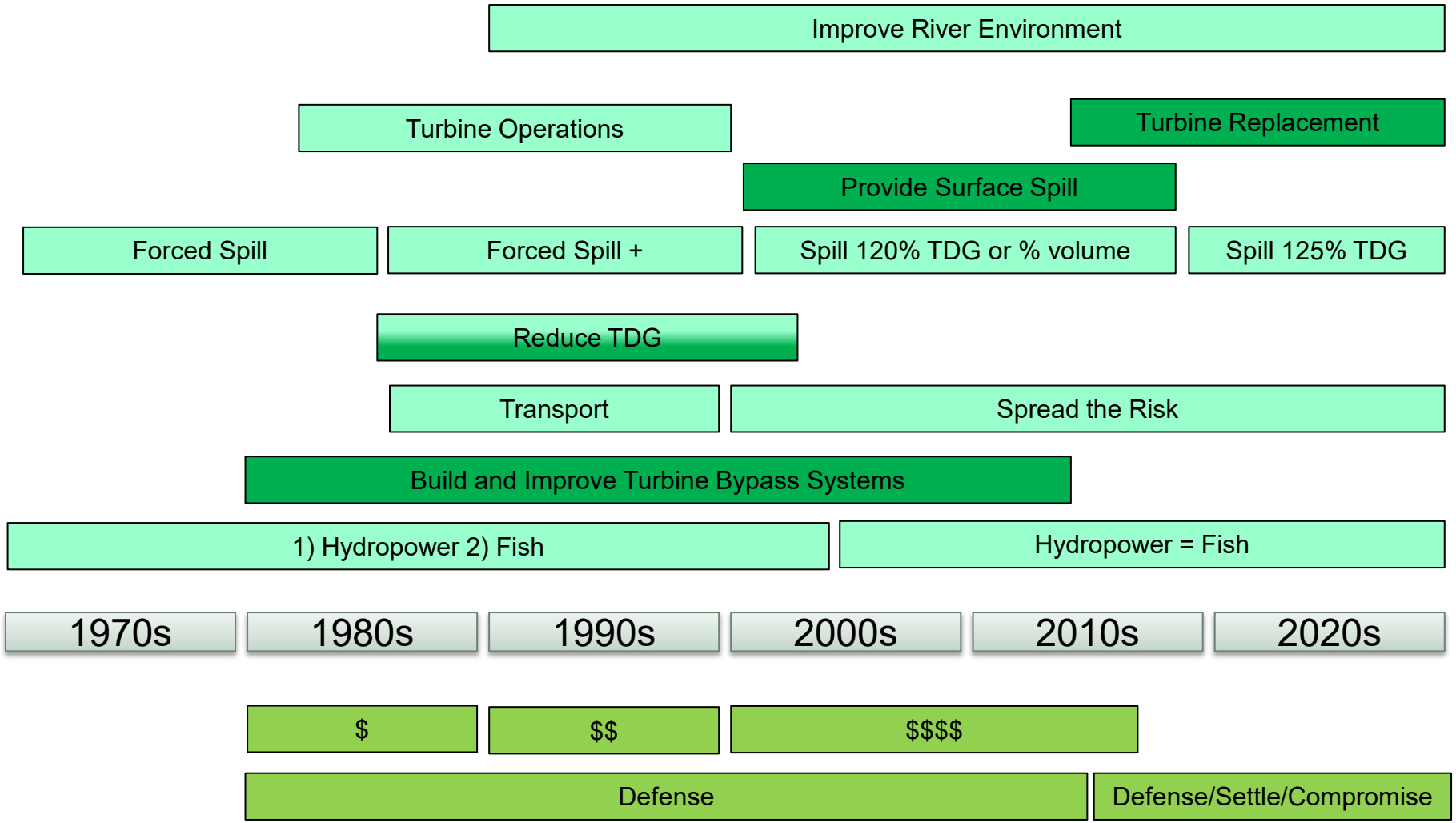
Walla Walla District, USACE
26 July 2022



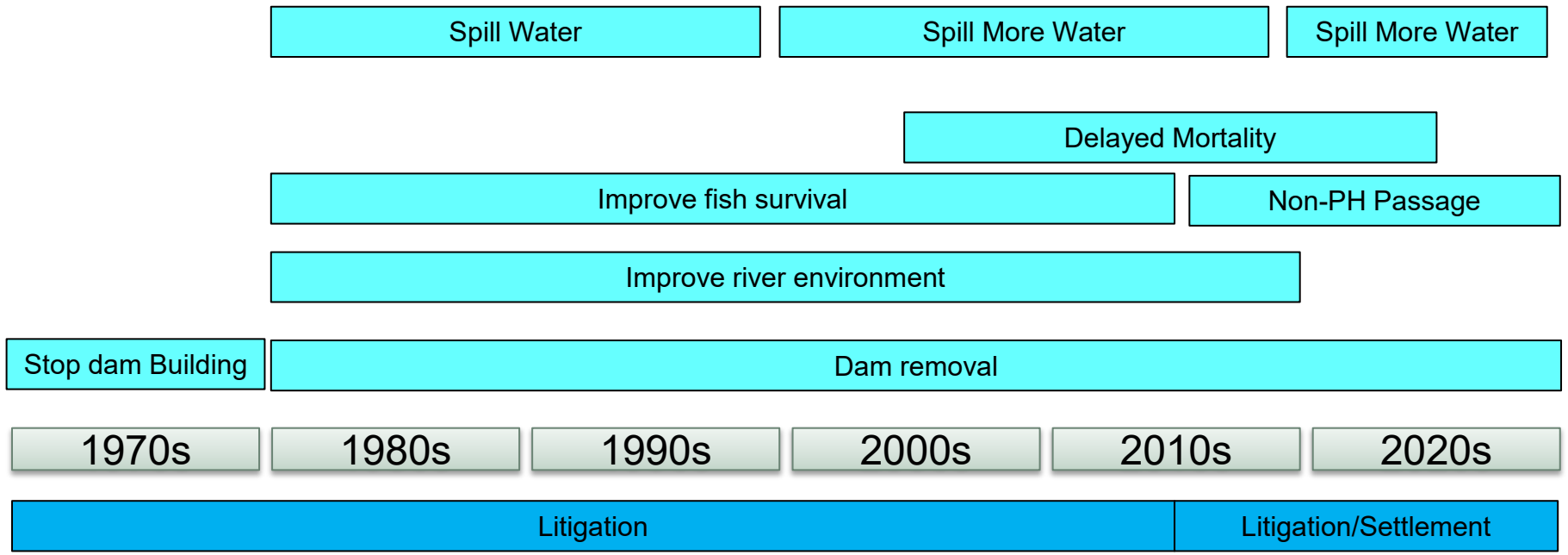
US Army Corps of Engineers®


Mica
Revelstoke
Arrow Lakes
Duncan
Keenleyside
Kootenay Lake
Canada
U.S.
Grand Coulee
Chief Joseph
Wells
Rocky Reach
Rock Island
Wanapum
Priest Rapids
Columbia R.
Albeni Falls
Libby
Hungry Horse
Noxon
Pend Oreille Lake
Flathead Lake
Kerr
Little Goose
Lower Granite
Dworshak
Seattle
WA
MT
N
Ice Harbor
The Dalles
Portland
Bonneville
McNary
John Day
Canyon
Oxbow
Brownlee
ID
Willamette R.
OR
Cascade
Deadwood
Lucky Peak
Arrowrock
Anderson Ranch
Swan Falls
CJ Strike
Upper Salmon Falls
Milner
Snake R.
Minidoka
American Falls
Jackson Lake
Palisades
CA
NV
Corps of Engineers Dams
Dams owned by Others
Bureau of Reclamation Dams

PHILOSOPHIES – ACTION AGENCIES MEET THE MISSION



PHILOSOPHIES – PLAINTIFFS REMOVE THE DAMS



JUVENILE FISH PASSAGE THROUGH TURBINES

Operations

1% Criteria
– Limits the operating range during juvenile fish passage season so limits the amount of power to be produced
– May have some benefits to survival

Improvements

Screened Bypass system
– Reduced turbine passage
– Opportunity to transport
Fish Friendlier Units
– New units and modify draft tube
  • 1,2,3 at Ice Harbor

High

Reasonable operations of current units
New units are much improved

Low

Old units have lowest survival route
Very Few Fish pass this way

JUVENILE PASSAGE THROUGH SPILLWAYS

Operations

Changed to small amount or only forced spill to very high levels of spill

Construction

Flow Deflectors
– Dramatically decreased TDG in the river
– Designed to operate at the optimized spill volumes of the late 1990s to 2000s

Spillway Weirs
– Surface passage provides an improved route
– Detection of fish

High

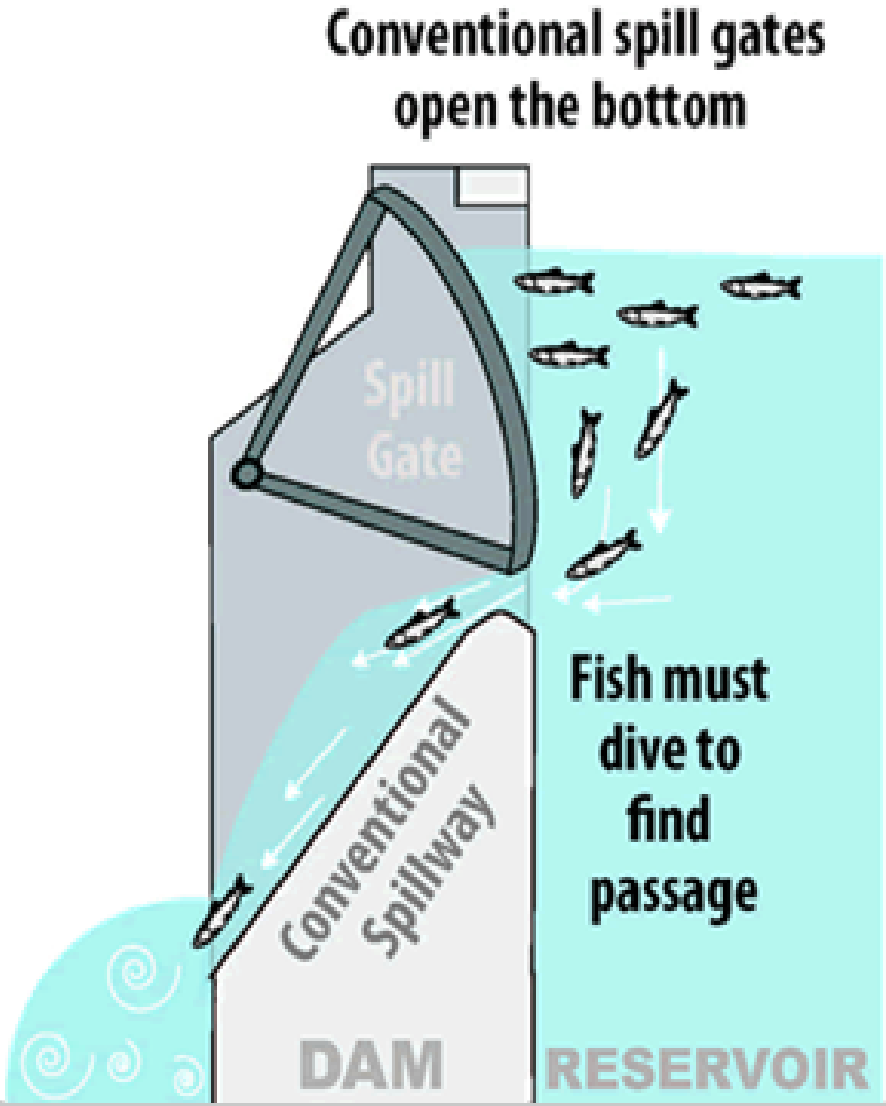
Construction actions made a big difference
One of the highest routes of survival

Low

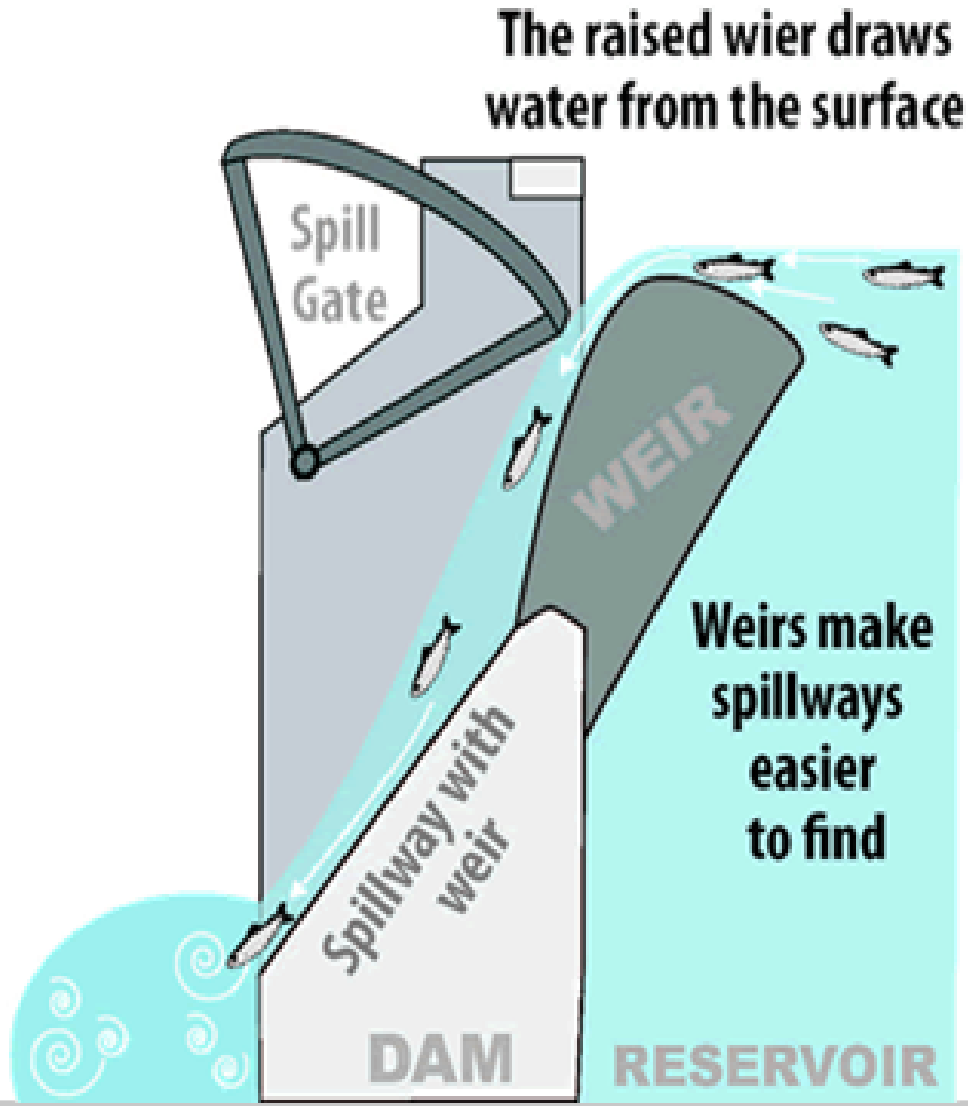
Higher spill has unknown effects
Reduces the financial viability of the project

Juvenile Fish Passage Operations - Spillways

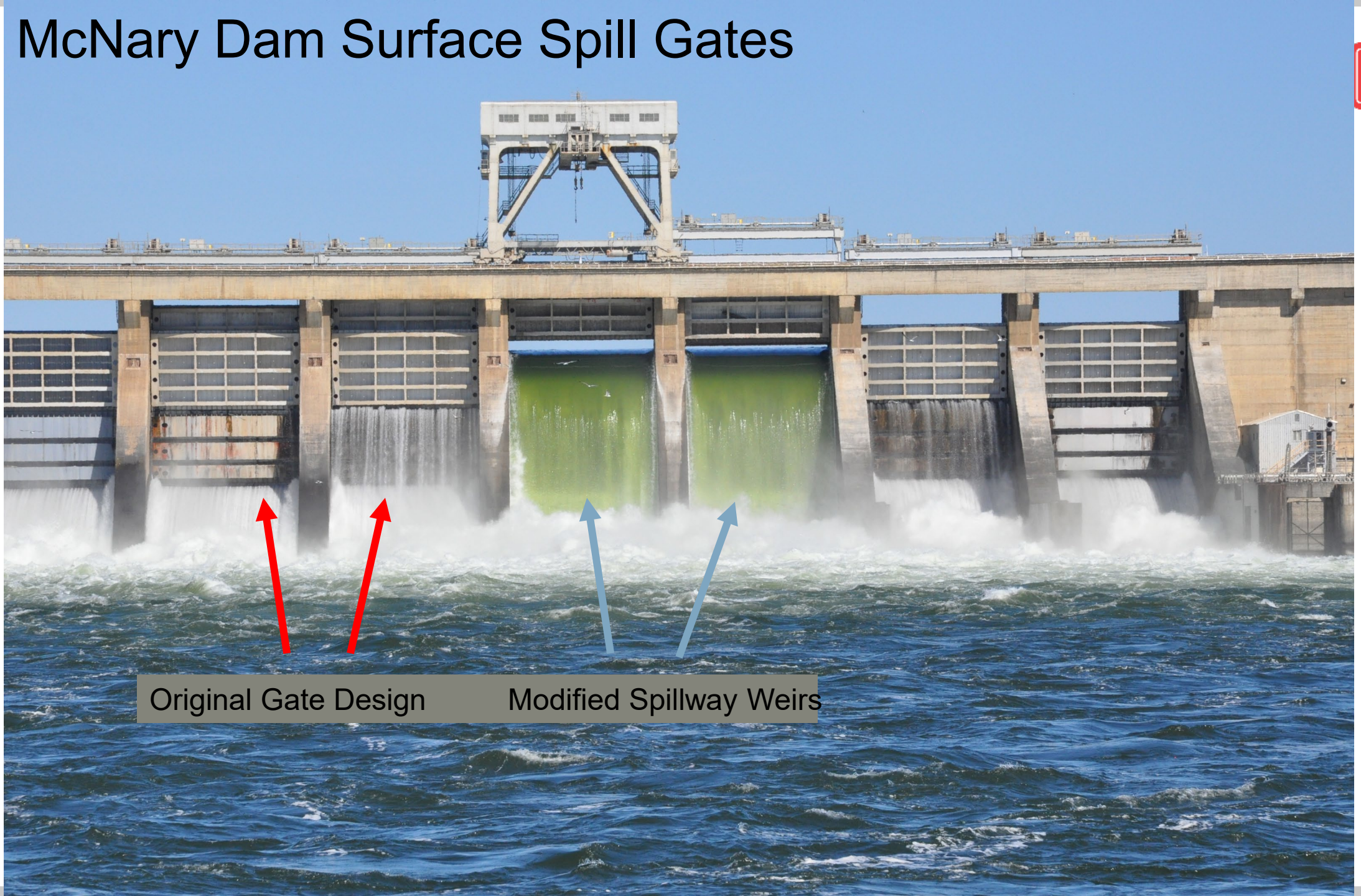
Deep spill



Surface spill



McNary Dam Surface Spill Gates



BYPASS SYSTEMS

Operations

Transport fish via barges and trucks
Bypass fish at times when transportation does not appear effective

Construction

Screens at all 4 facilities
Bypass Facilities at all 4 facilities
– Transportation facilities at upper 3 dams

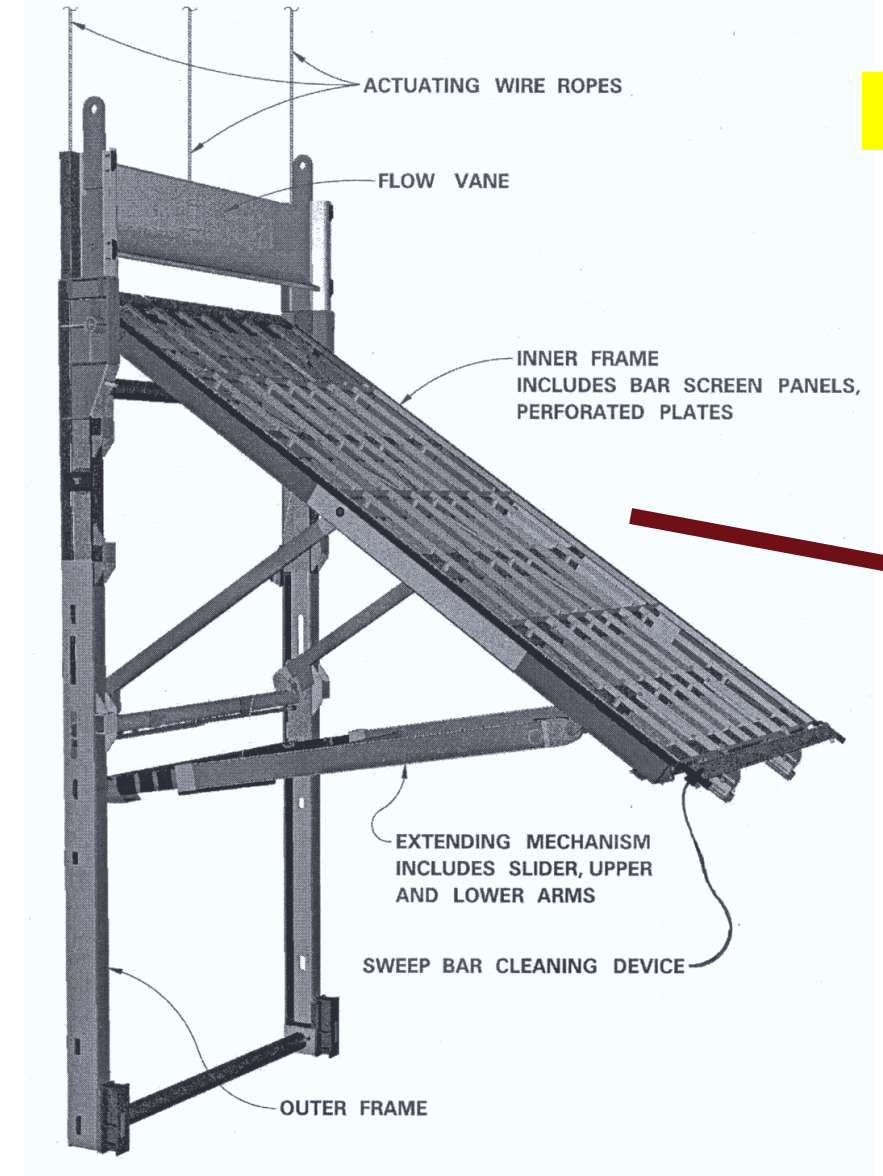
High

Construction actions made a big difference
Higher routes of survival

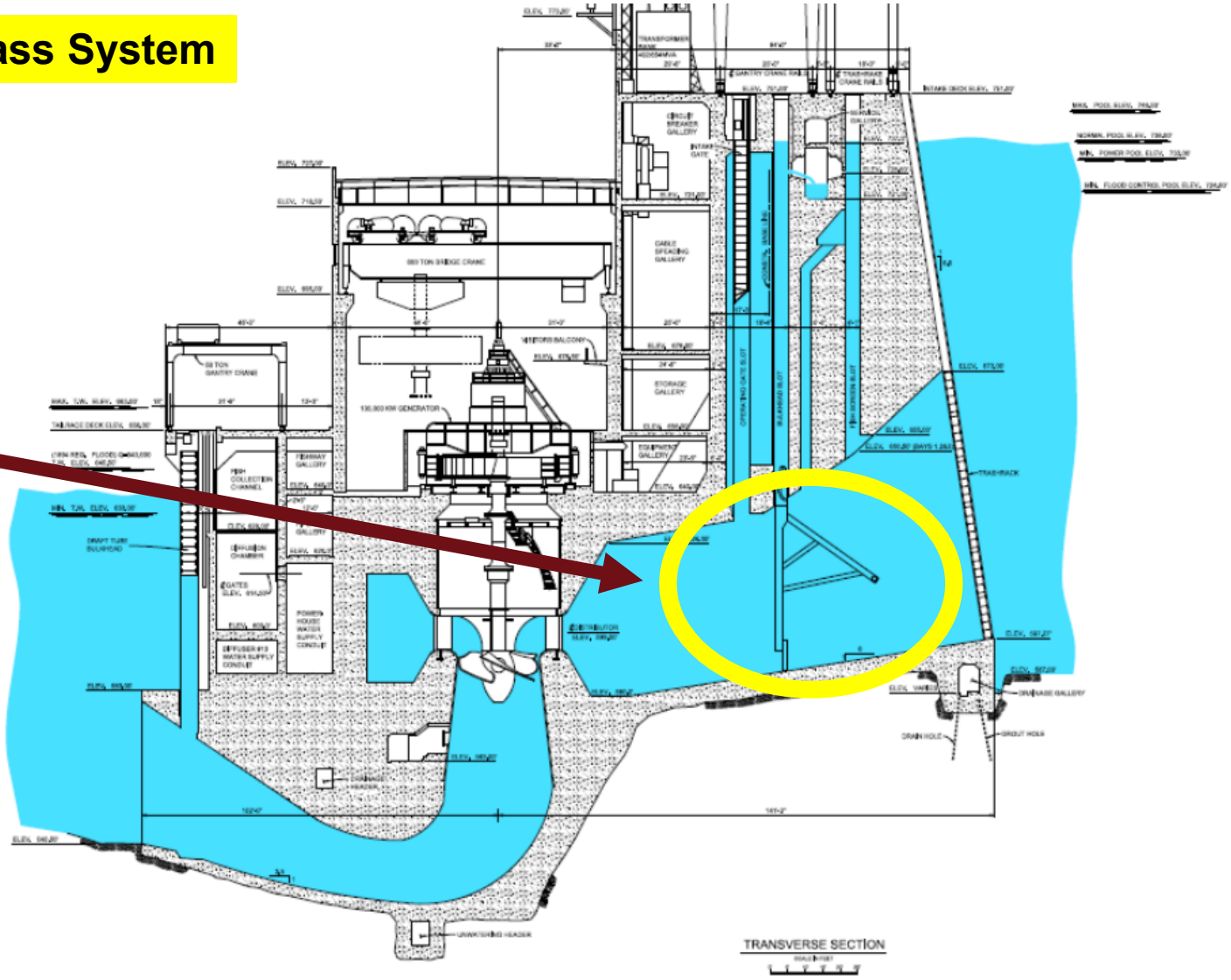
Low

Higher spill reduces fish in this route
Expensive to maintain

Juvenile Fish Passage Operations - Bypass

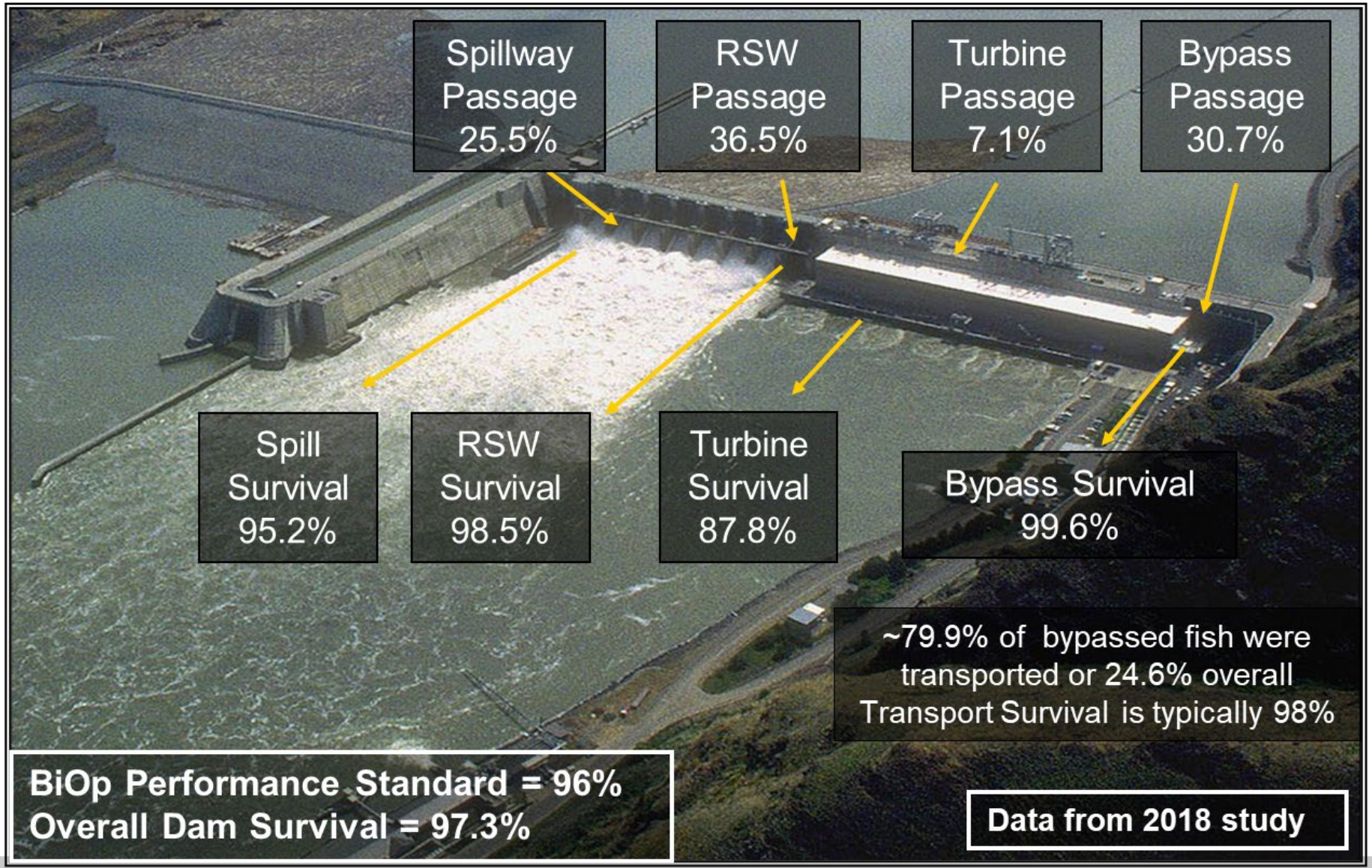


Bypass System



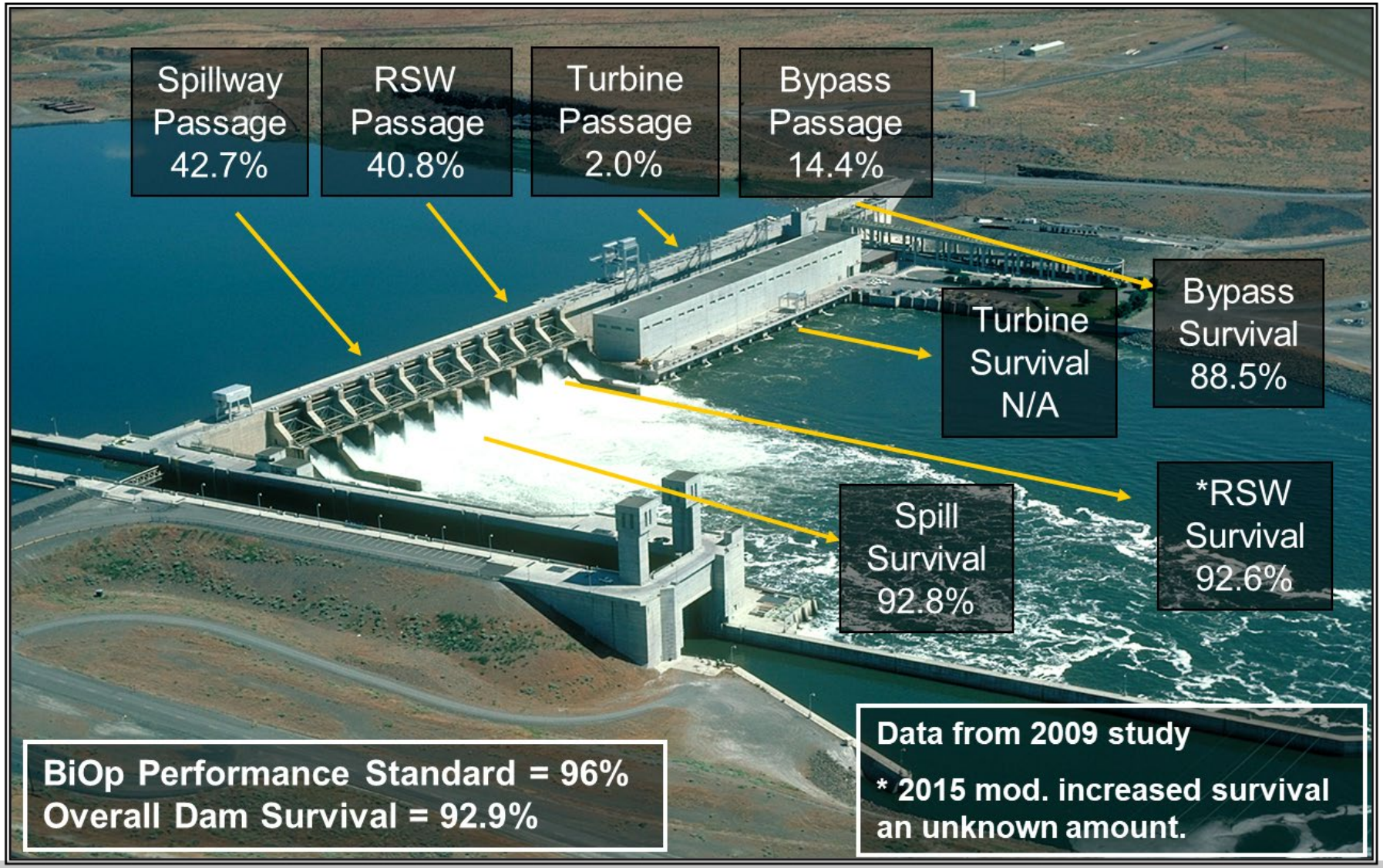
Lower Granite Dam

Yearling Chinook Passage & Survival Estimates

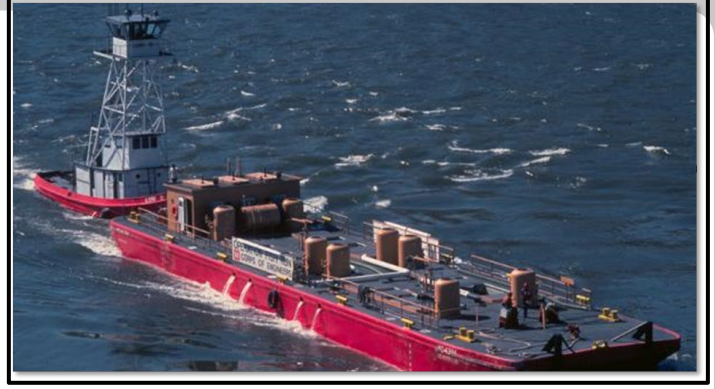


Ice Harbor Dam

Yearling Chinook Passage & Survival Estimates



TRANSPORTATION



Operations

Use of barges and trucks to transport fish downstream after being bypassed

- Studies showed how to optimize

Construction

Same as bypass systems

High

Transportation is effective in most years
Helps to spread the risk

Low

Higher spill reduces fish transported (diff)
Expensive to maintain

RIVER ENVIRONMENT

Operations

Dworshak Release of cool water
reduced temps in lower Snake
Reduced reservoir elevation
– Lower pools thought to move fish through quicker

Construction

While dredging, we have built shallow water habitat for fish in the Lower Granite Reservoir using dredged material

2021; Warmest summer air temperatures and lowest river flows on record

Anatone, WA
↓ 70-75 F

Below Ice Harbor Dam
↓ 68-73 F

Lower Snake River Temperature Report for July 2021

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	Anatone - Snake River Near Anatone (ANQW)				Lower Granite Dam forebay (LWG)				Lower Granite tailwater - Snake R. below dam (LGNW)				Little Goose Dam forebay (LGSA)				Little Goose Dam tailwater (Snake R. below Little Goose) (LGSW)				Lower Monumental Dam forebay on Snake River (LMNA)				Lower Monumental tailwater below the dam on Snake River (LMNW)				Ice Harbor Dam forebay (IHRA)				Ice Harbor tailwater- Snake R. below Goose Is. (IDSW)			
Date	Min	Avg	Max	>68.05	Min	Avg	Max	>68.05	Min	Avg	Max	>68.05	Min	Avg	Max	>68.05	Min	Avg	Max	>68.05	Min	Avg	Max	>68.05	Min	Avg	Max	>68.05	Min	Avg	Max	>68.05	Min	Avg	Max	>68.05
07 01	72.6	74.2	75.4	24/24	65.7	66.7	67.5	0/24	66.3	66.7	67.6	0/24	68.7	69.4	70.1	24/24	68.4	68.5	68.7	24/24	68.8	69.3	70.1	24/24	68.6	69.2	69.5	24/24	68.2	68.8	69.9	24/24	68.3	69.0	69.6	24/24
07 02	72.4	74.0	75.0	24/24	65.6	66.0	66.4	0/24	65.9	66.1	66.3	0/24	68.5	69.6	70.0	24/24	68.6	68.8	69.1	24/24	69.9	70.4	70.8	24/24	69.3	69.9	70.3	24/24	69.2	69.9	70.8	24/24	69.5	70.1	70.6	24/24
07 03	72.5	73.7	74.9	24/24	65.8	66.7	67.4	0/24	66.1	66.6	67.0	0/24	69.5	70.2	70.8	24/24	68.6	69.3	69.8	24/24	69.8	70.4	70.9	24/24	69.9	70.2	70.5	24/24	70.4	70.6	70.8	24/24	70.5	70.9	71.3	24/24
07 04	73.4	74.1	75.2	24/24	66.2	66.7	67.4	0/24	66.7	67.0	67.4	0/24	68.5	69.3	70.1	24/24	68.4	68.9	69.2	24/24	69.2	69.5	70.0	24/24	69.7	69.8	69.9	24/24	70.2	70.4	70.8	24/24	70.5	70.8	71.2	24/24
07 05	73.2	74.0	75.1	24/24	66.0	66.7	68.1	1/24	66.6	66.9	67.2	0/24	68.5	69.0	69.5	24/24	68.3	68.6	69.2	24/24	69.4	69.6	70.1	24/24	69.7	69.9	70.1	24/24	70.2	70.5	70.8	24/24	70.4	70.9	71.4	24/24
07 06	72.5	73.4	74.1	24/24	65.9	66.7	67.7	0/24	66.8	67.1	67.6	0/24	68.6	70.2	71.3	24/24	68.3	69.1	69.7	24/24	70.1	70.6	70.8	24/24	70.1	70.5	70.8	24/24	71.0	71.2	71.4	24/24	71.0	71.7	72.4	24/24
07 07	72.2	73.2	73.8	24/24	66.5	67.1	68.1	1/24	66.7	67.1	67.5	0/24	68.6	69.2	69.8	24/24	68.1	68.8	69.2	24/24	69.6	70.0	70.6	24/24	69.7	70.3	70.7	24/24	71.0	71.2	71.6	24/24	71.2	71.8	72.1	24/24
07 08	71.1	72.6	73.5	24/24	65.7	67.2	69.1	6/24	66.3	66.9	67.8	0/24	68.2	69.3	70.6	24/24	67.9	68.5	69.0	17/24	69.4	69.7	70.3	24/24	69.6	69.9	70.2	24/24	71.0	71.2	71.7	24/24	71.0	71.7	72.5	24/24
07 09	71.1	72.1	72.8	24/24	66.6	67.7	69.0	6/24	67.7	67.8	67.9	0/24	69.0	70.1	70.7	24/24	69.0	69.3	69.7	24/24	69.7	70.0	70.4	24/24	70.0	70.3	70.6	24/24	71.2	71.4	71.9	24/24	71.5	72.0	72.4	24/24
07 10	71.7	72.0	72.4	24/24	67.8	68.4	69.1	20/24	67.9	68.1	68.3	14/24	69.5	70.4	71.1	24/24	69.4	69.7	70.2	24/24	69.9	70.2	70.5	24/24	70.3	70.6	70.9	24/24	71.7	72.0	72.3	24/24	71.9	72.5	73.1	24/24
07 11	70.4	71.4	72.1	24/24	67.2	68.0	69.0	11/24	67.9	68.3	68.6	19/24	68.5	69.5	70.5	24/24	69.2	69.5	69.7	24/24	69.5	69.7	69.9	24/24	70.0	70.2	70.3	24/24	71.5	71.7	71.9	24/24	71.8	72.2	72.6	24/24
07 12	70.3	71.2	71.8	24/24	66.7	67.5	68.1	1/24	67.3	67.8	68.1	1/24	69.2	70.0	70.9	24/24	69.1	69.6	70.2	24/24	69.7	70.3	71.0	24/24	69.9	70.4	71.0	24/24	71.3	71.5	71.8	24/24	71.6	72.3	72.9	24/24
07 13	70.1	71.4	72.6	24/24	65.8	66.7	67.7	0/24	66.8	67.4	67.7	0/24	68.5	69.4	71.0	24/24	69.5	69.8	69.9	24/24	70.4	70.5	70.8	24/24	70.4	70.6	70.8	24/24	71.2	71.4	71.8	24/24	71.7	72.1	72.5	24/24
07 14	71.3	72.0	73.0	24/24	65.7	66.4	67.2	0/24	66.9	67.2	67.5	0/24	69.2	69.8	70.4	24/24	69.5	69.8	70.2	24/24	69.9	70.3	70.8	24/24	70.5	70.6	70.8	24/24	71.4	71.6	72.0	24/24	72.1	72.5	72.9	24/24
07 15	71.4	72.3	73.1	24/24	65.0	65.8	66.7	0/24	65.6	66.2	66.8	0/24	68.7	69.3	69.8	24/24	68.9	69.2	69.5	24/24	70.0	70.2	70.6	24/24	70.3	70.5	70.7	24/24	71.4	71.5	71.8	24/24	71.7	72.0	72.5	24/24
07 16	71.3	72.1	72.7	24/24	65.2	66.3	67.7	0/24	65.6	65.8	65.9	0/24	68.5	68.8	69.1	24/24	68.5	68.8	69.2	24/24	69.9	70.1	70.6	24/24	69.9	70.2	70.4	24/24	71.3	71.6	72.3	24/24	71.4	71.7	72.1	24/24
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07 18	71.4	72.0	72.9	24/24	65.4	66.3	67.1	0/24	66.5	66.7	67.0	0/24	70.1	70.8	71.1	24/24	69.6	70.1	70.6	24/24	70.4	70.9	71.3	24/24	70.6	71.0	71.3	24/24	72.0	72.2	73.2	24/24	72.5	72.8	73.3	24/24
07 19	71.7	72.2	72.6	24/24	65.8	66.3	66.9	0/24	66.2	66.5	66.9	0/24	68.7	69.5	70.8	24/24	69.3	69.6	70.0	24/24	69.9	70.2	70.5	24/24	70.3	70.6	70.8	24/24	71.8	72.0	72.3	24/24	72.2	72.5	72.8	24/24
07 20	71.5	71.9	72.4	24/24	65.2	66.2	67.1	0/24	66.0	66.4	66.5	0/24	67.7	68.5	69.2	20/24	68.1	68.7	69.2	24/24	69.5	69.8	70.0	24/24	69.8	70.1	70.4	24/24	71.3	71.6	71.9	24/24	71.8	72.2	72.4	24/24
07 21	71.2	71.7	72.8	22/22	64.8	65.5	66.5	0/22	65.6	66.2	66.6	0/24	67.3	68.0	69.0	9/23	67.4	68.0	68.3	18/22	69.9	70.0	70.2	23/23	69.9	70.1	70.4	23/23	71.2	71.4	71.7	24/24	71.5	71.8	72.3	24/24
07 22	71.1	71.8	72.7	19/19	67.5	67.5	67.5	0/1	65.4	65.7	66.0	0/24	67.8	68.8	69.9	20/24	67.3	68.2	68.7	12/20	70.0	70.4	70.9	24/24	69.8	70.2	70.6	24/24	71.5	71.9	72.5	24/24	71.4	72.1	73.0	24/24
07 23	70.7	71.5	72.6	24/24	65.4	66.6	67.4	0/24	65.0	66.2	66.6	0/24	69.1	69.9	70.3	24/24	68.5	68.9	69.4	24/24	70.0	70.6	71.2	24/24	69.9	70.5	70.7	24/24	71.7	71.9	72.3	24/24	72.1	72.5	73.1	24/24
07 24	70.7	71.6	72.9	24/24	65.9	66.8	67.9	0/24	64.9	66.2	67.2	0/24	67.8	68.5	69.3	20/24	68.4	68.7	69.0	24/24	69.3	69.6	70.1	24/24	69.5	69.9	70.4	24/24	71.4	71.6	71.9	24/24	71.7	72.2	72.9	24/24
07 25	71.2	72.2	73.4	24/24	66.7	67.4	68.1	1/24	65.7	66.7	67.5	0/24	67.7	68.2	69.1	11/24	68.2	68.6	69.0	24/24	69.1	69.2	69.3	24/24	69.4	69.6	69.8	24/24	71.2	71.3	71.4	24/24	71.5	72.0	72.7	24/24
07 26	72.0	72.5	73.1	24/24	67.1	67.5	68.0	0/24	65.6	66.8	67.6	0/24	67.5	67.7	68.2	1/24	68.0	68.3	68.6	21/24	69.1	69.4	69.7	24/24	69.1	69.5	69.9	24/24	71.0	71.2	71.6	24/24	71.3	71.9	72.4	24/24
07 27	71.7	72.2	72.7	24/24	67.7	68.1	68.6	16/24	66.0	67.1	67.8	0/24	67.2	67.7	68.6	4/24	67.8	68.1	68.4	14/24	69.4	69.7	70.1	24/24	69.3	69.5	69.7	24/24	70.9	71.1	71.3	24/24	71.5	71.8	72.1	24/24
07 28	71.6	72.6	74.1	24/24	67.8	68.4	68.9	21/24	66.5	67.3	68.0	0/24	67.6	68.3	69.5	13/24	67.8	68.3	68.8	14/24	69.4	69.7	70.0	24/24	69.3	69.7	70.1	24/24	71.0	71.3	71.7	24/24	71.5	72.0	72.5	24/24
07 29	73.0	73.9	75.4	24/24	68.8	69.1	69.5	17/17	66.9	67.7	68.2	8/24	67.9	68.3	68.8	14/17	67.8	68.2	68.6	9/17	69.5	69.7	70.2	17/17	69.6	69.9	70.5	17/17	71.1	71.3	71.5	17/17	71.7	72.0	72.6	17/17
07 30	73.4	74.4	75.4	24/24	68.7	69.4	70.2	24/24	67.9	68.4	68.9	16/24	67.8	68.2	68.6	16/24	68.3	68.5	68.9	24/24	69.2	69.5	69.8	24/24	70.0	70.4	70.7	24/24	70.8	71.1	71.4	24/24	71.7	72.1	72.6	24/24
07 31	73.8	74.7	75.7	24/24	69.1	69.9	70.5	24/24	68.0	68.6	69.7	23/24	67.5	68.1	68.3	13/24	68.2	68.6	69.0	24/24	68.7	69.1	69.3	24/24	69.5	69.8	70.2	24/24	70.6	70.7	71.2	24/24	71.4	71.7	72.1	24/24
>68.05	31	31	31	737/737	3	6	13	149/712	0	4	6	81/744	20	28	31	621/736	24	30	31	681/731	31	31	31	736/736	31	31	31	736/736	31	31	31	737/737	31	31	31	737/737

Temperature in Degrees Fahrenheit

<32 32 34 36 38 40 42 44 46 48 50 52 54 56 58 60 62 64 66 68 70 72 74 76 78 80 82 84 >86

Bold, red text denotes values above 68.05°F.

https://pweb.crohms.org/tmt/documents/ops/temp/202107.lsnake.html

ADULT PASSAGE

Operations

Limit delays by turbine priorities
Spill patterns and volume to decrease circulation in the tailrace
Operate cooling structures to enhance passage when hot
98% effectiveness

Construction

Modify ladders to increase passage
- Shad – Ice Harbor
- All Species – Lower Granite

Modify to provide cooler temperatures

High

Adult fish passage is typically great
Temperature improvements are effective

Low

High temperatures can affect survival
High spill can delay adults

Fish Passage - Summary

Adult passage with fishways – Very effective

Juvenile passage

- RSW – Very effective
- Spillway – Effective to a point
- Turbines – Lowest survival but lowest used route
  – Being improved with new turbine technology
- Bypass systems – Effective
- Transport program – Effective

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IN A NUTSHELL, POSITIVE CHANGES FROM THE 1970S TO THE 2010S

Operations

Improved coordination
Worked to optimize operations
Changed from a hydropower focus to fish focus
Improved river environment
Improved bypass of fish
Improved in-river survival

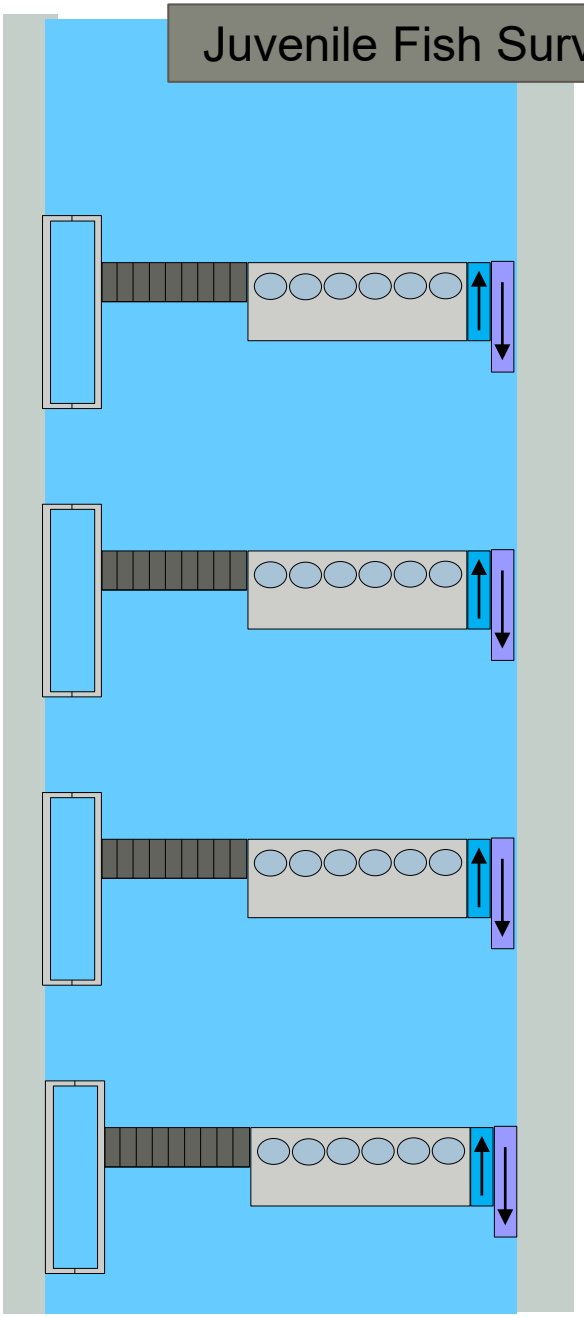
Construction

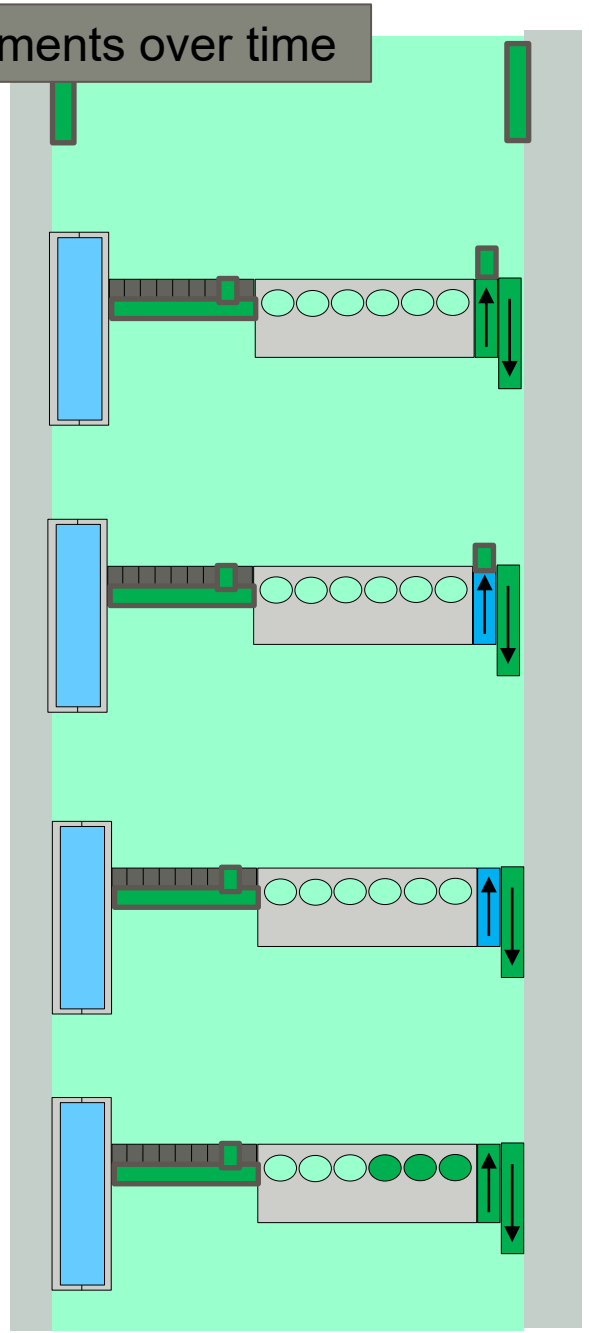
Improved spillways
Improved turbines
Improved bypass systems
Improved in-river habitat
Improved adult passage
Improved transport

Juvenile Fish Survival Improvements over time

1970s

Est Juv Survival less than 60%





2010s

Juv Survival about 75%

RIVER OPERATIONS NOW

SPRING RIVER OPERATIONS HISTORY

Year(s)	Events	Hydraulic Modeling	Biological Testing	TDG Criteria
Pre-2001	Spillway Deflectors	Extensive	Extensive	120% TR, 115% FB
2001 - 2017	Spillway Weirs, Spill for Fish	Extensive	Extensive	120% TR, 115% FB
2018	Gas Cap Spill	Extensive	Limited	120% TR, 115% FB
2019	Flex Spill - 120% w/ no FB limit	None, no monitoring	Limited	120% TR
2020	Flex Spill - 125% w/ no FB limit	None, some monitoring	Limited	125% TR

BACKGROUND

2020 Flex Spill Operation:

- Maximize spill without exceeding 125% TDG as measured at tailrace fixed monitoring station
- Up to 8 hrs Performance Spill per day, can be in two different blocks

Project	2018 120%/115% TDG Gas Cap (kcfs)	2019 120% TDG Gas Cap* (kcfs)	2020 125% TDG Gas Cap* (kcfs)	Spill Increase 2018 - 2019	Spill Increase 2019 - 2020	Spill Increase 2018 - 2020
Lower Granite	37	52	82	41%	58%	**122%**
Little Goose	30	54	81	80%	50%	**170%**
Lower Monumental	33	45	111	36%	**147%**	**236%**
Ice Harbor	86	90	111	5%	23%	29%
McNary	164	192	261	17%	36%	59%

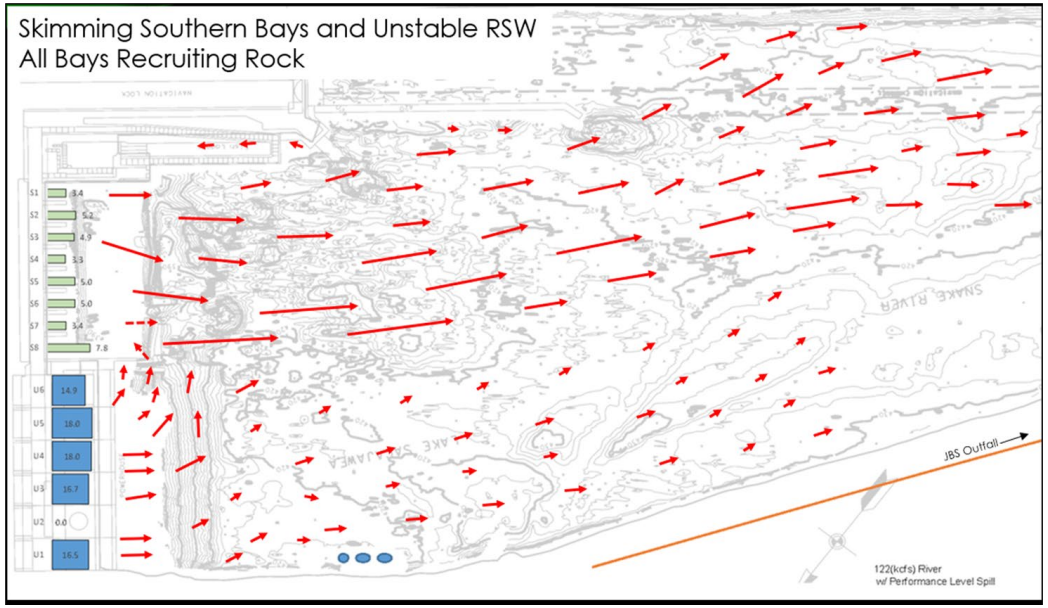
* Post-season calculated actual gas cap values

BOTTOM LINE

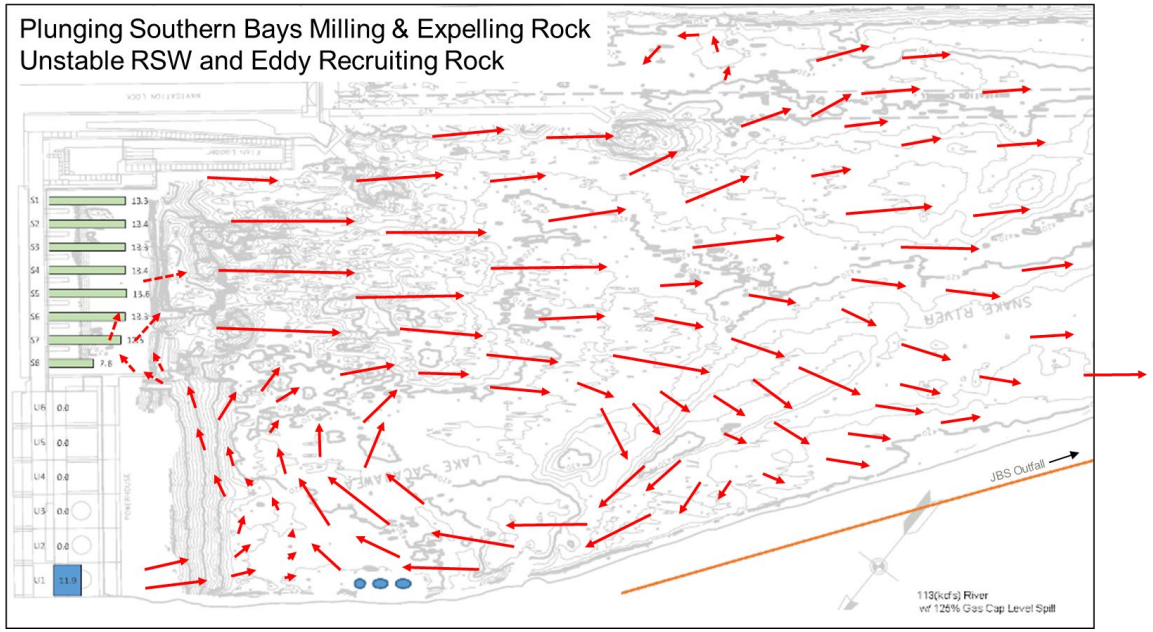
- **Biologically**
  - Some believe that this is the best operation for fish as they are passing via non powerhouse route
  - No extensive studies for these operations as in the past, so the Corps is unsure of the effects on salmon
  - Time will tell with adult returns
  - We have seen other species in the river with some TDG issues but not many for salmon
  - High spill can delay adult passage

- **River environment**
  - Water is likely travelling somewhat faster through the system
  - Past modeling tried to get water past the tailrace quickly to avoid predators and reduce risk of high TDG but high levels of spill and low turbine output cause circular currents in the tailrace
  - Can cause challenges with Navigation

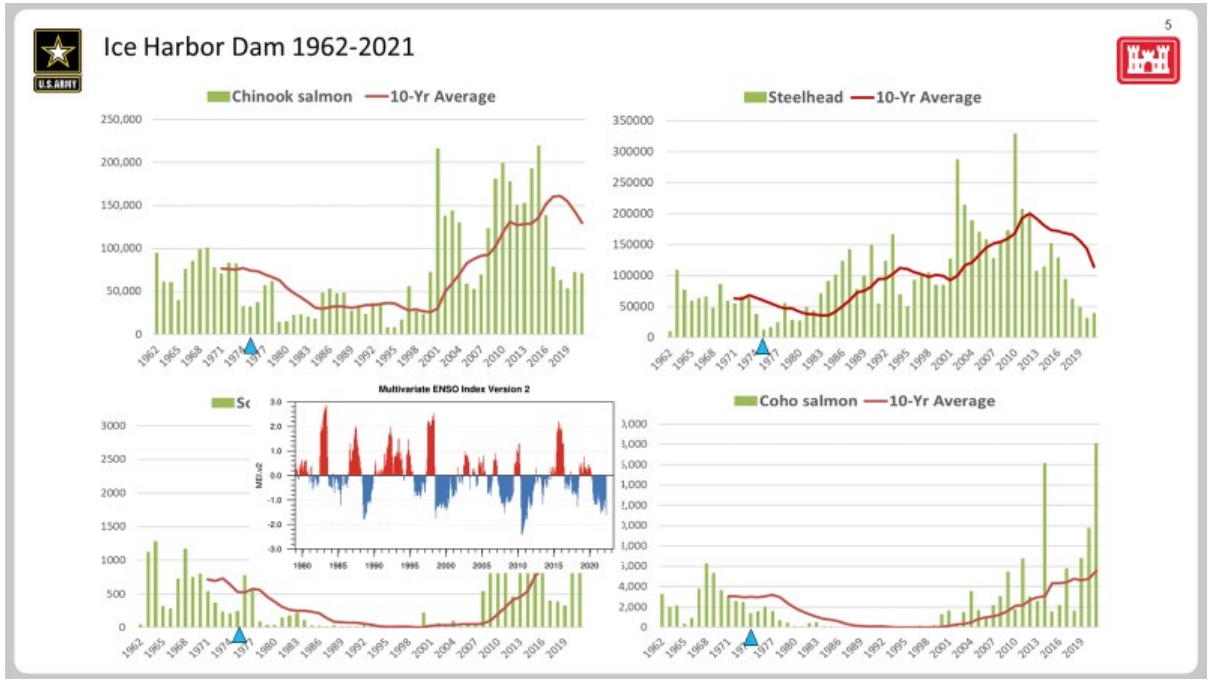
- **Infrastructure**
  - Current system was designed for 120% TDG, we are operating outside of the design range
  - We are uncertain what erosion, etc it is having on our projects
  - Many changes in operations has an increased wear and tear on equipment

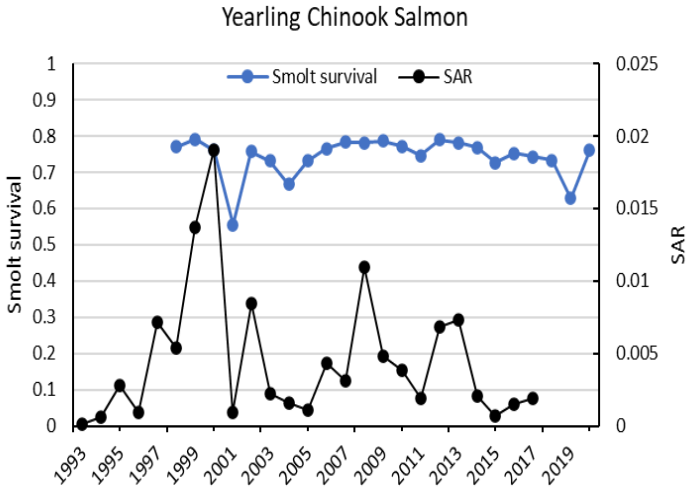


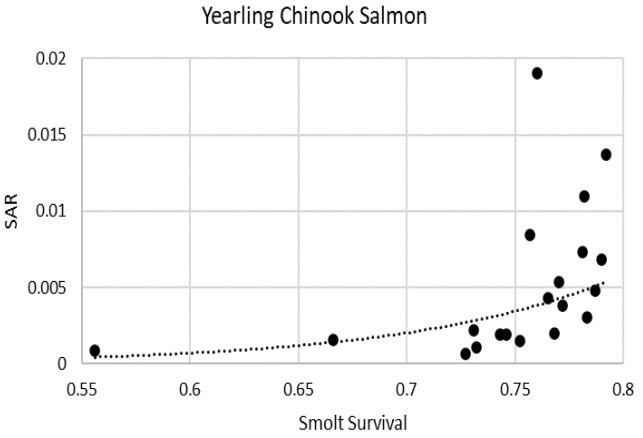
May 4th – High Flow



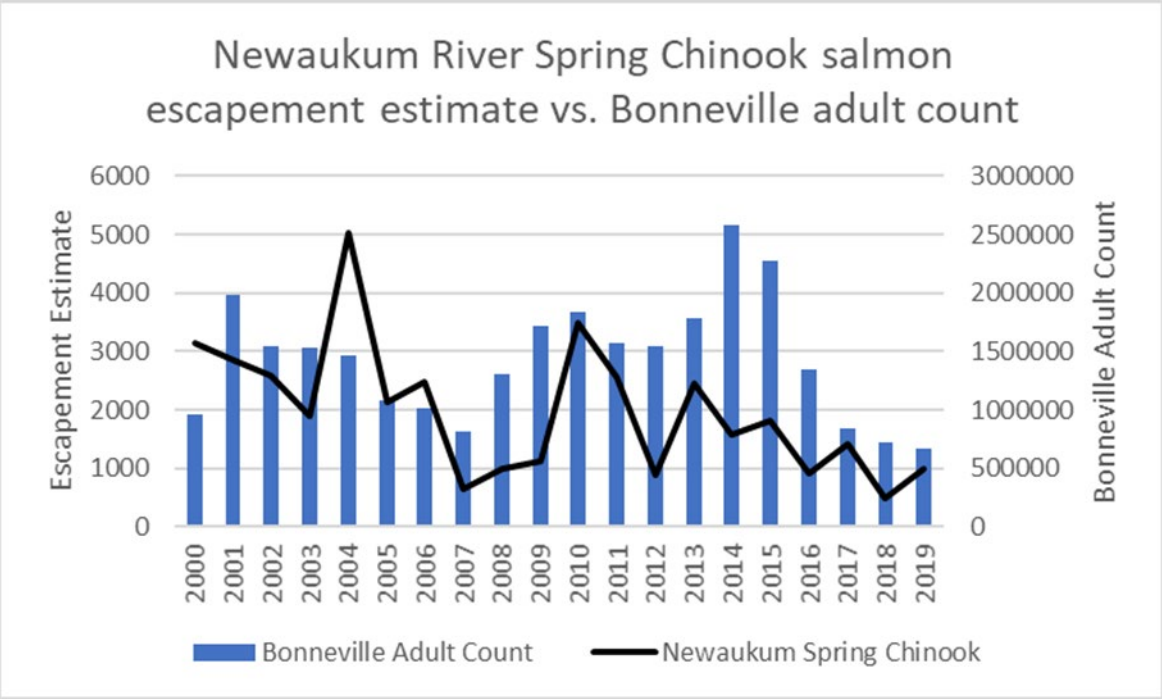
BACKUP SLIDES

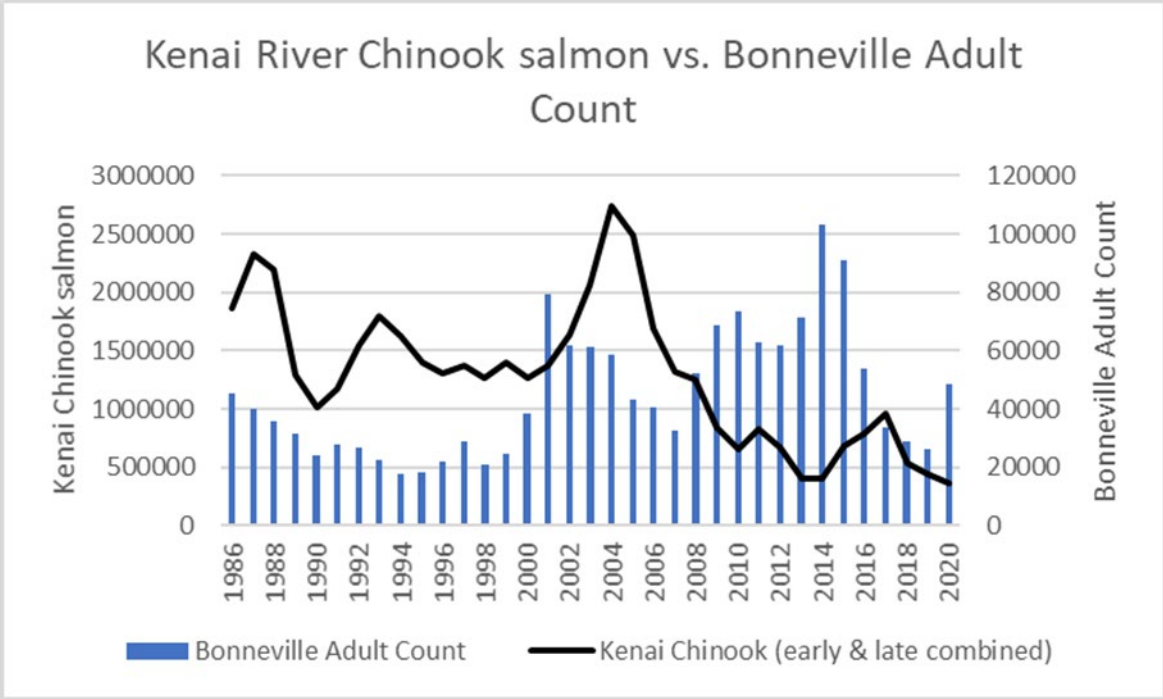

Ice Harbor Dam 1962-2021
5
Chinook salmon
10-Yr Average
Steelhead
10-Yr Average
Multivariate ENSO Index Version 2
Coho salmon
10-Yr Average


Yearling Chinook Salmon
Smolt survival
SAR
Smolt survival
SAR


Yearling Chinook Salmon
SAR
Smolt Survival

Adult Returns





2022 FISH RETURNS TO LOWER GRANITE AS OF 7/20

Adult Counts 2022

76,671 Chinook
– Highest return since 2016 as of this date
– Since 1975, ranked 9TH highest (46 years)
– Hatchery fish comprise the majority

1,790 Sockeye
– Highest return since 2014 as of this date
– Since 1962 (Ice Harbor counts), 2nd highest return year
– Hatchery fish are a huge component

Steelhead and Coho (too early to say)

WHAT OTHER THINGS ARE INFLUENCING FISH POPULATIONS?

- Hatcheries
  - Genetics
  - Competition of hatchery with wild fish in the streams
  - Size of juveniles are larger than wild fish
- Harvest
  - Ocean
  - Below Bonneville
  - Zone 6 Fishery
  - Tributaries
  - Spawning Grounds
- Habitat
  - Climate Change (Ocean, Migration, Spawning) Grounds
  - Spawning Grounds
- Predation
  - Birds
    - More and more pelicans every year
    - Studies on Terns and cormorants continue
  - Non-Native Fish
    - Bass
    - Walleye
    - Catfish
    - Crappie/Perch
  - Increased forage species
    - Juvenile Shad
    - Siberian Prawns