

Mechanisms of delayed mortality in outmigrating juvenile Chinook salmon

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delayed mortality n (20c) 1: mortality of fish that occurs in the estuary or ocean that is related to their earlier experiences in the hydrosystem



Objective: *assess the physiological, health, and behavioral status of barged and ROR fish*

Sampling design--2006

1. DWK & RR

2. LGR (3x)

3. BON (2x)

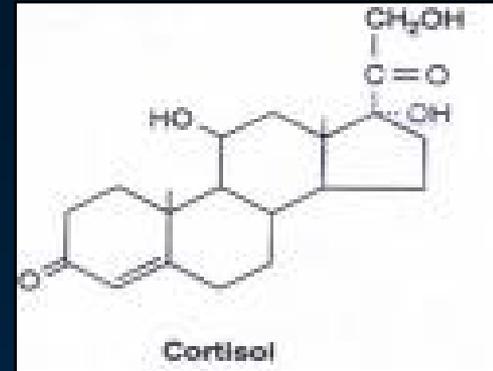
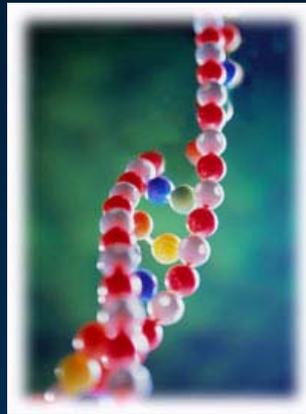
4. Barges (LGR → BON; 3x)

ATPase, T4, CRT, predation

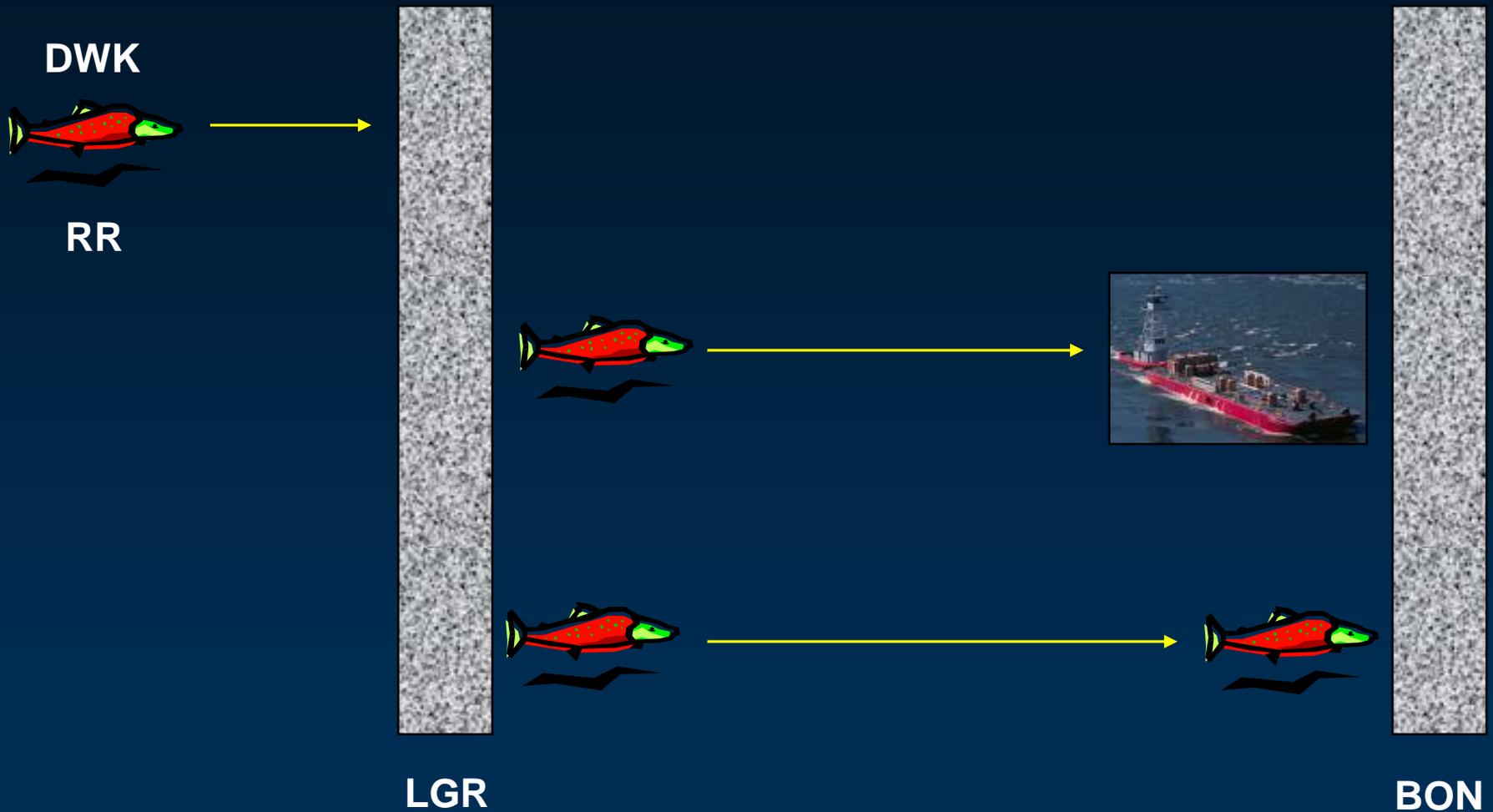
Gene expression
Pathogens



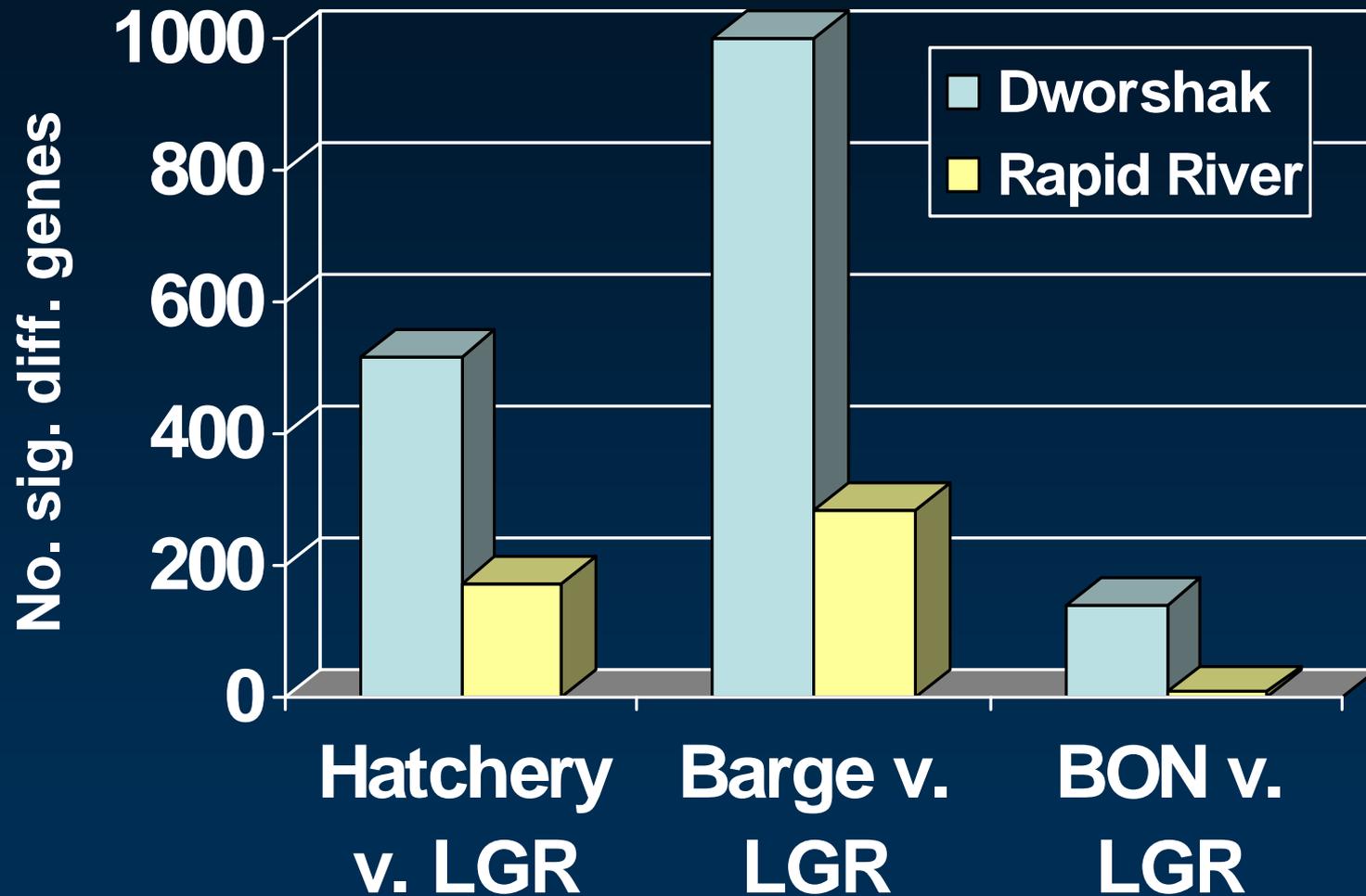
DNA microarrays



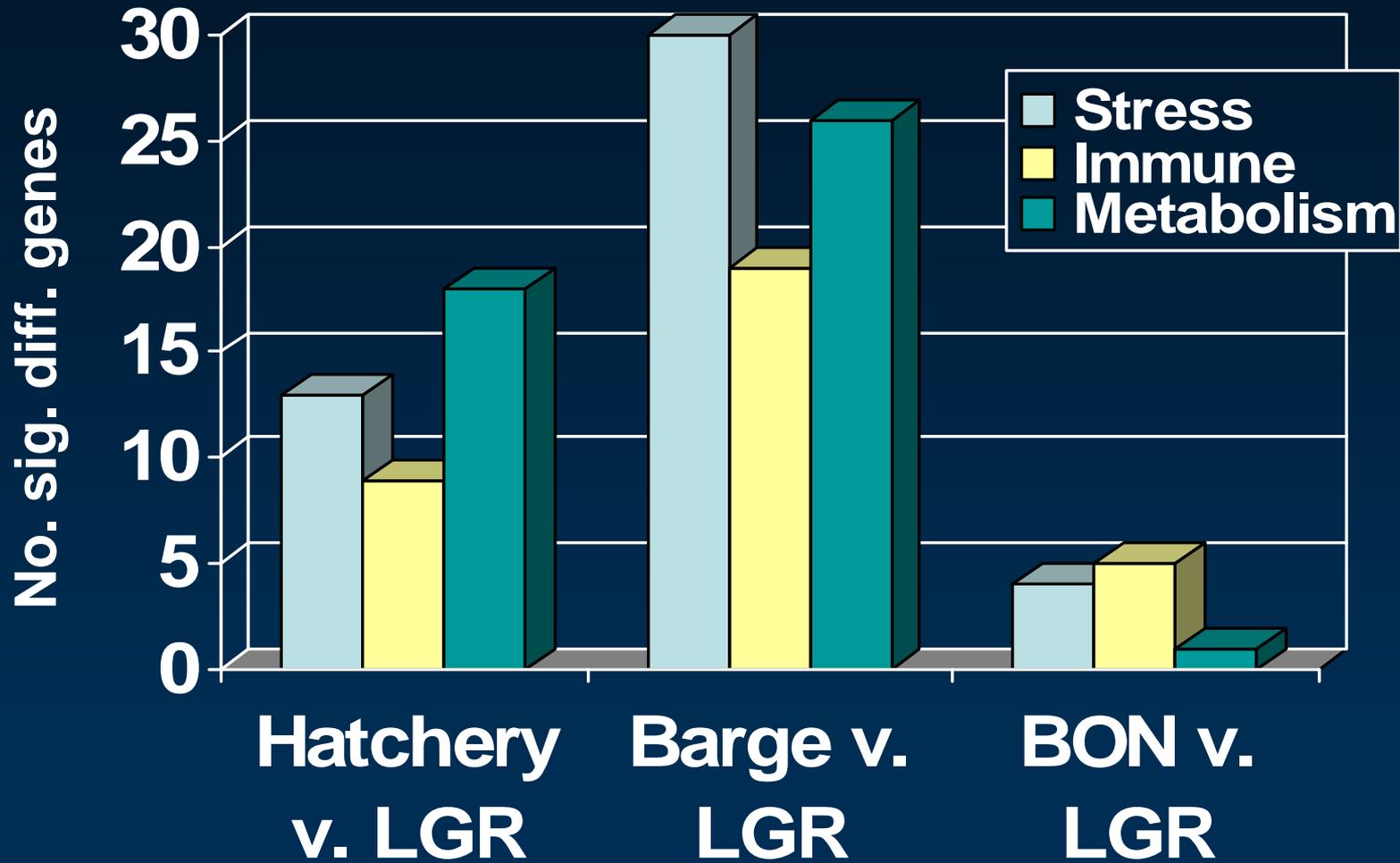
Data comparisons



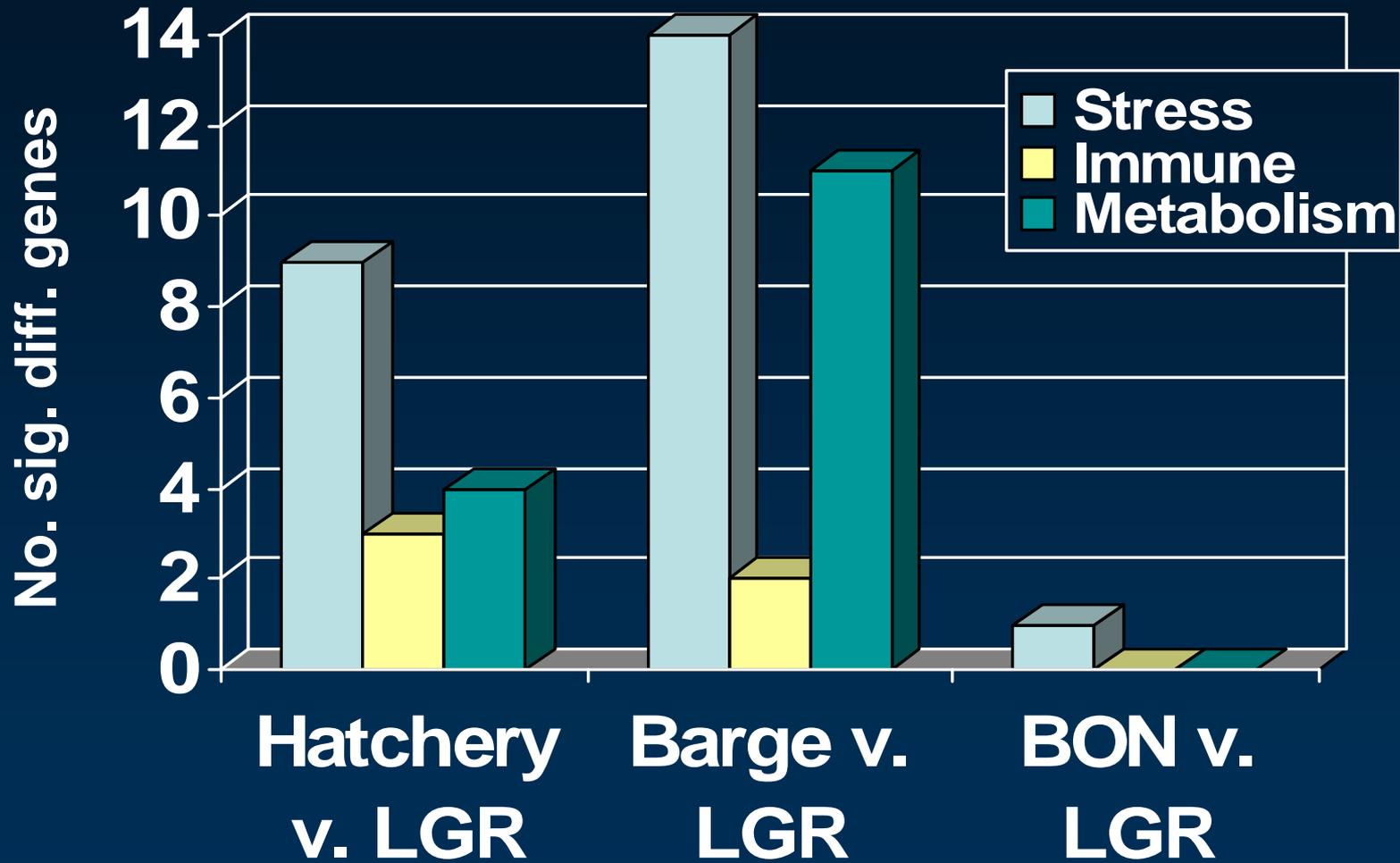
Transcriptional response to release, barging, and migrating in-river



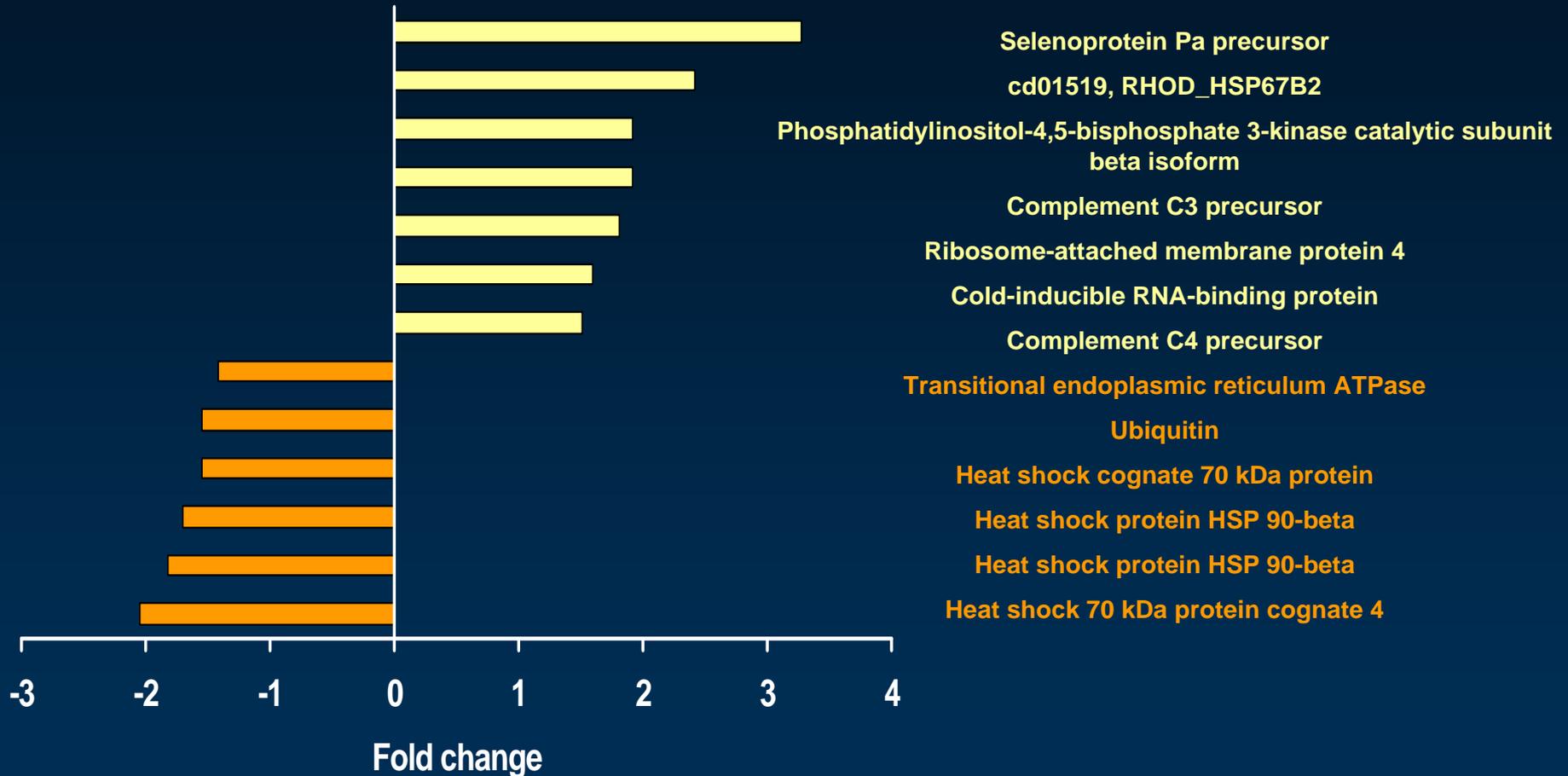
Physiological systems affected--DWK



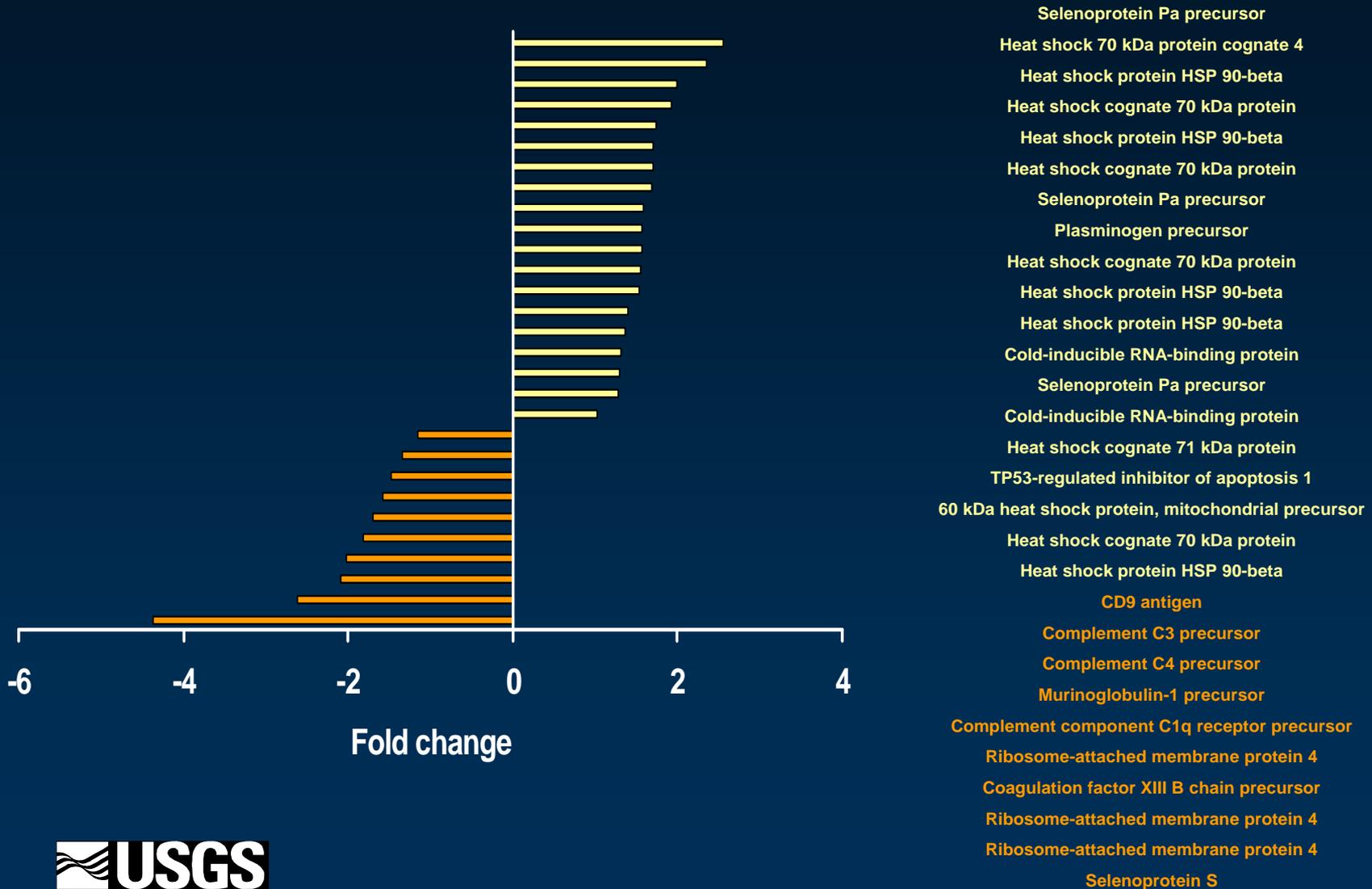
Physiological systems affected--RR



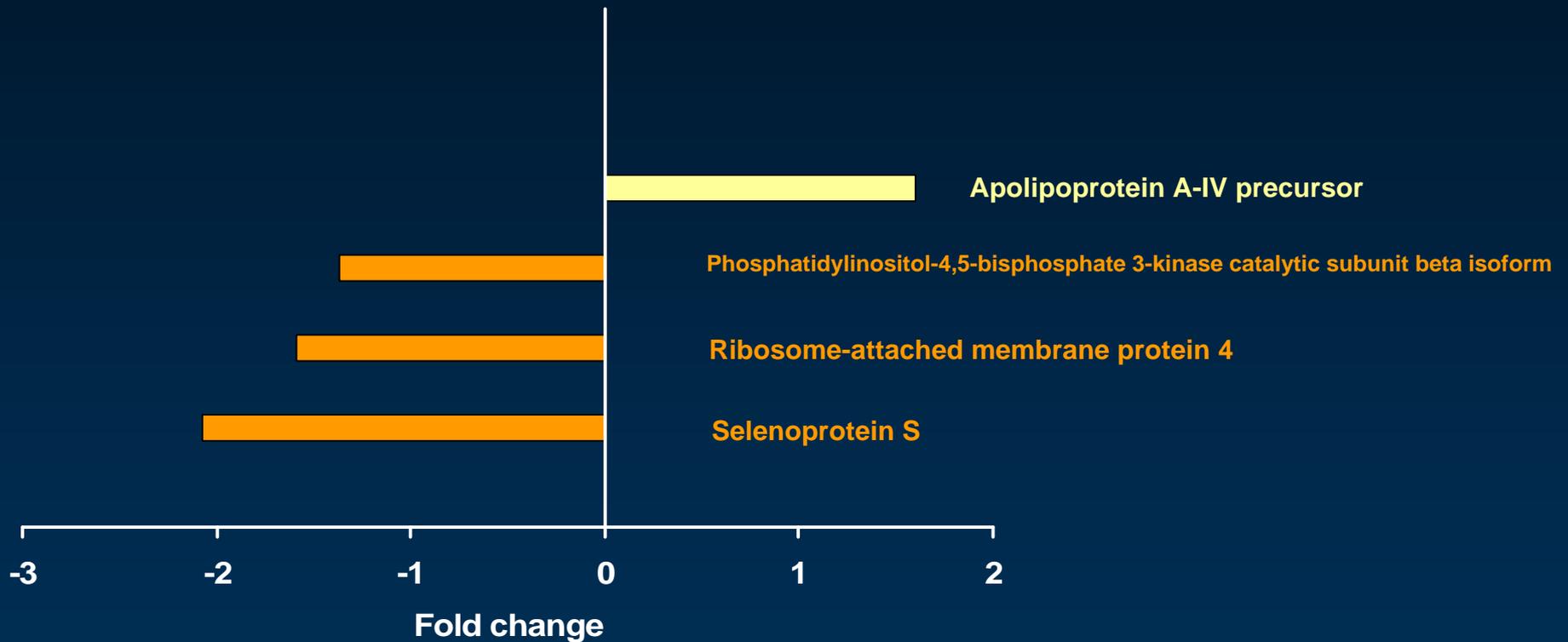
DWK stress-related genes—hatchery v. LGR



DWK stress-related genes—barge v. LGR



DWK stress-related genes—BON v. LGR





Summary and conclusions

- Sig. transcriptional response to release and barging, less so for ROR
- Results were hatchery dependent (DWK > RR)
- Few differences in ROR fish—culling?
- Barged fish had the most sig. response in stress, immune, and metabolism genes
- Stress or disease-related mechanisms of delayed mortality?

Fish health



Pathogen Assays

Bacteria

- Renibacterium salmoninarum*(Rs)
- Yersinia ruckeri*
- Aeromonas salmonicida*
- Flavobacterium psychrophilum*

Parasites

- Nucleospora salmonis*
- Ceratomyxa shasta*

Viruses

- Infectious hematopoietic necrosis virus (IHNV)*



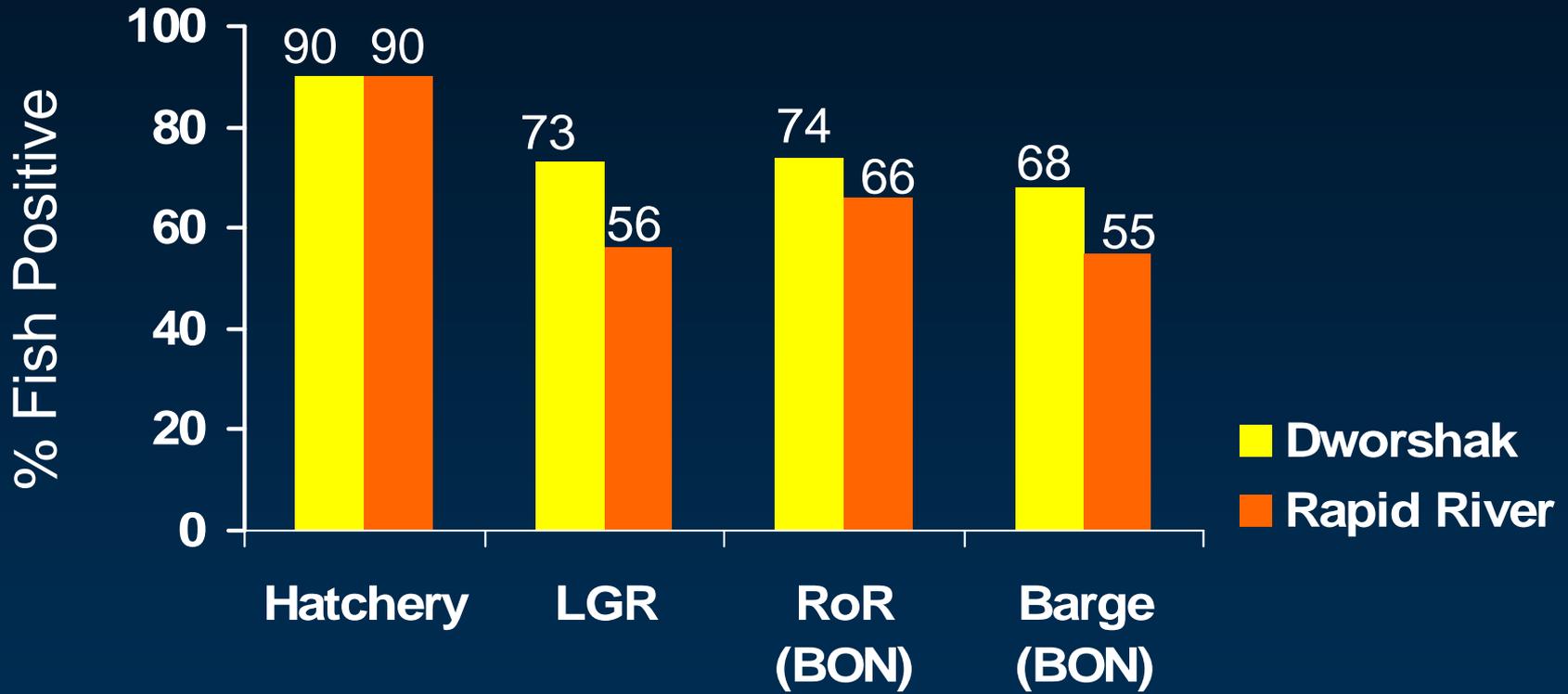
Pathogen assay sample sizes

	Hatchery of Origin	
	Dworshak	Rapid River
Pre-release	10	10
Lower Granite	30	27
Bonneville (RoR)	31	29
Barge (BON)	37	47

Pathogen assay results (221 fish)

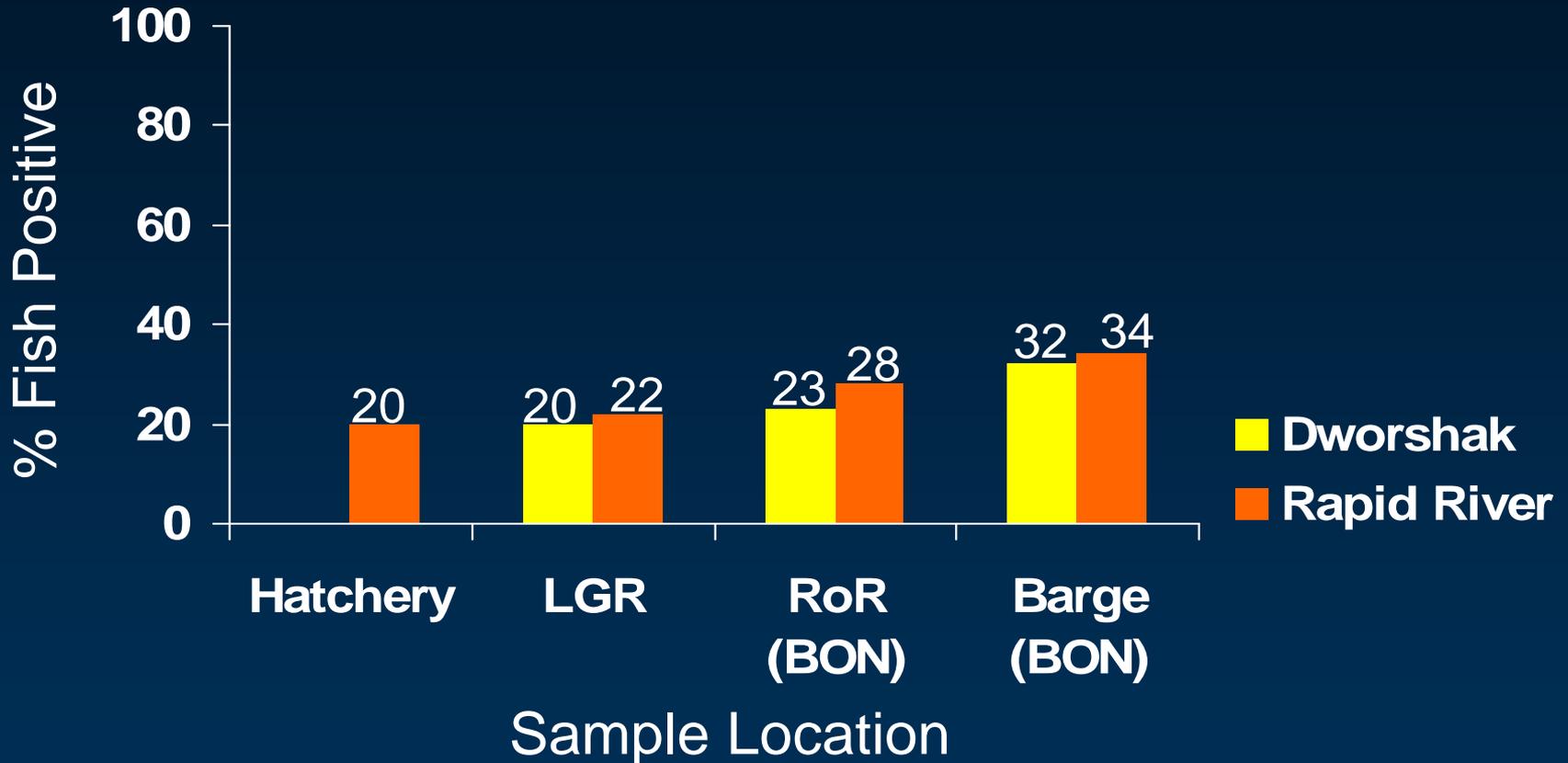
Pathogen	No. positive (%)
<i>R. salmoninarum</i>	148 (67%)
<i>N. salmonis</i>	57 (26%)
IHNV	25 (11%)
<i>A. salmonicida</i>	2 (<1%)
<i>Y. ruckeri</i>	1 (<1%)
<i>F. psychrophilum</i>	1 (<1%)

Renibacterium salmoninarum (Rs) detection by sample location



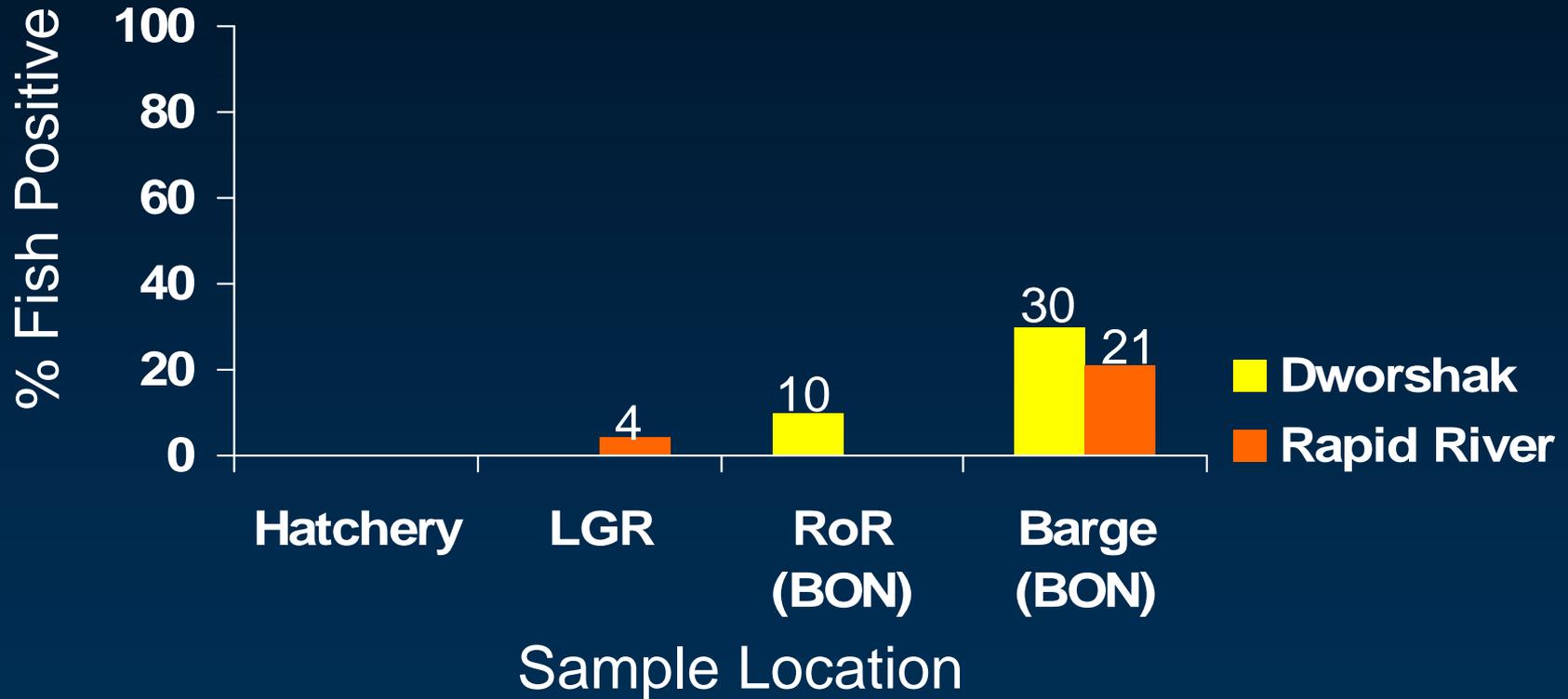
Sample Location
Numbers above bars = % positive fish

Nucleospora salmonis (Ns) detection by sample location



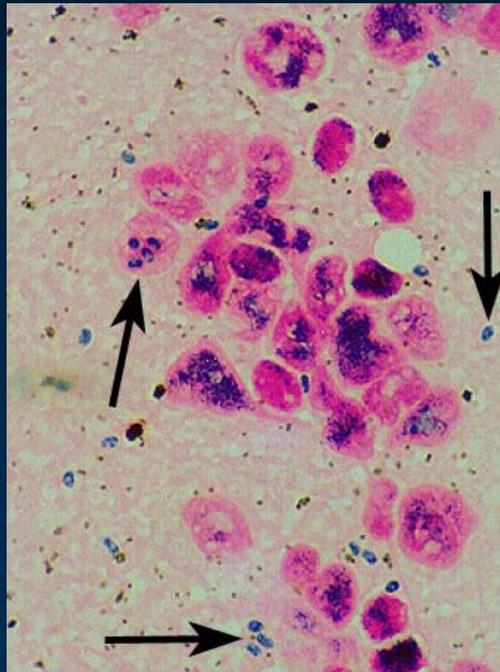
Numbers above bars = % positive fish

Infectious hematopoietic necrosis virus (IHNV) detection by sample location



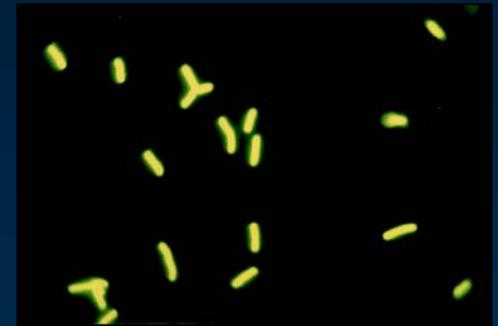
Numbers above bars = % positive fish

Possible contribution of the most prevalent pathogens to delayed mortality?



Renibacterium salmoninarum

- *Renibacterium salmoninarum*, the causative agent of bacterial kidney disease (BKD), is one of the most important pathogens of wild and cultured salmonids in the Pacific Northwest.



Nucleospora salmonis

- *N. salmonis* is a microsporidian parasite of salmonids that infects the nuclei of immature white blood cells and can cause a leukemia-like condition.
- *N. salmonis* infects salmonids in the CRB.



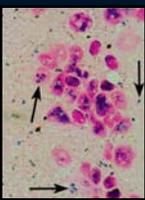
Rs and *N. salmonis*

- Can cause chronic, subclinical infections in freshwater and seawater.
- Can render fish more susceptible to secondary infections.
- Infected fish may survive or die depending on their overall condition and levels of other stressors they encounter.

Infectious hematopoietic necrosis virus (IHNV)

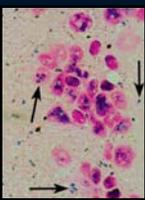
- IHNV is the most important virus of salmonids in the PNW.
- IHNV can cause acute mortality, esp. in fry.
- Some species (incl. CHN) can be carriers, shedding virus that can be transmitted to other fish.





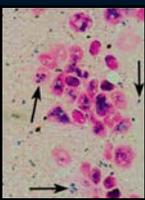
Summary and conclusions

- Pathogens most commonly detected were *Rs* (67% of fish), *N. salmonis* (26% of fish), and IHNV (11% of fish).
- Fish with *Rs* and *N. salmonis* likely had chronic infections
- Detections from some gill, mucus or fin samples may represent pathogens shed into the water by other fish and recently acquired by the fish tested.



Summary and conclusions

- IHNV-positive fish from barges likely had acquired the infection earlier.
- Stressful conditions during collection or transport may have enhanced expression of IHNV.
- IHNV-infected fish may shed virus into the barges and infect other fish.



Summary and conclusions

- Concurrent infections with other pathogens may have enhanced the expression of IHNV in carriers.
 - 76% of IHNV-positive fish in this study were also positive for *Rs*, *N. salmonis*, or both.
 - St-Hilaire et al. (2001) showed that IHNV could only be isolated from carrier CHN that were also infected with *Rs* or *P. salmonis*.

Acknowledgements

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Summary of previous results

- **ATPase:** many “smolts”, few diffs in barged & ROR
- **T4:** ND in barged & ROR
- **Cortisol:** highest in ROR
- **Predation:** 20 mm diff in prey size led to selection

