Pacific Northwest Project Technical Information

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SUBJECT: The "Ghost" Haunting the NRC/NAS Columbia River Report Is "Empirical Science"—And the Ghost Has Daunting Implications for State Proposals Toward Columbia River Water Management

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Introduction:

Prepared for the WADOE, the NRC/NAS report[1] on the impacts of future Columbia River water right withdrawals and water management has been haunted by a lack of quantitative explanation, or more appropriately termed, "Empirical Science."

A great uneasiness pervades the report's conclusions, with contradictory statements by the report authors incanting that the actual fish impacts cannot be measured, but nevertheless the non-measurable impacts are deemed to create "substantial risk" to fish survival. There exists an eerie, disturbing feeling that a critical "presence" does exist here, but hidden from direct awareness, or at least shielded from clear vision by the NRC/NAS study's strained rationalizations.

That "presence" is, in fact, "Empirical Science." When the doors of perception are opened, and "Empirical Science" is brought into a clear and focused light, its revealing implications for proposed state actions become troublesome.

Background and Review of Recent Flow-Survival Data:

As stated by the NRC/NAS report, the primary emphasis on "risk" to migrating fish was directed toward low water-year events (like 2001), during the summer months (July-August), when peak water withdrawals and low flows coincided[2]

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[1] National Research Council/National Academy of Sciences, "Managing the Columbia River: Instream Flows, Water Withdrawals, and Salmon Survival ," NRC/NAS, 2004, at NAS Website.

[2] NRC/NAS pg. 60.

The dominant fish run affected during this period likely would be Mid-Columbia (wild) fall chinook, as well as other runs such as the ESA-listed Snake River fall chinook run.

For fish migrating through the Lower Snake River system and the John Day Pool, the basic empirical data and analyses for assessing the impacts of flow regimes on fish travel time, temperature and survival are contained within the following studies: 1) Smith, S. G., W. G., Muir, et al. 2002. *"Survival of Hatchery Subyearling Fall Chinook Salmon in the Snake River and Lower Snake River Reservoirs, 1998-2001."* Report by the National Marine Fisheries Service to the U.S. Department of Energy, BPA, Portland, OR; and 2) Muir, W. G., et al. 2004. *"Survival of Subyearling Fall Chinook Salmon in the Free-Flowing Snake River and Lower Snake River Reservoirs in 2003 and from McNary Dam Tailrace to John Day Dam Tailrace in the Columbia River from 1999 to 2002."* Report by the National Marine Fisheries Service to U.S. Dept. of Energy, BPA, Portland, OR.

The NRC/NAS authors actually referenced one of the reports (Smith and Muir, et al., 2002) as follows: "correlations were not significant between annual fish survival and the average river condition variables [flow, temperature, turbidity]".[3] No statistically significant flow-survival relationship could be detected for migrating fish within the mainstem Columbia River, even in a low water-year event like 2001 (*within year relationship*).

But there is much more to be understood about the empirical data and analyses.

These studies observed that water temperature and flow were highly correlated for the *combined data, 1999-2002 period.* For the combined data, flow and survival were moderately correlated, as was temperature and fish survival. When data for all years were combined (1999-2002), travel time versus flow and temperature relationships were not statistically significant (adjusted values). For between-year conditions, higher flows generally relate to higher survival rates; the year 2001 displayed lower survival rates compared to the other years. For analyses of individual years *(within-year operations)*, 1999-2001, there did not exist a statistically significant relationship between flow and survival or temperature and survival, but temperature did exhibit the highest level of correlation to survival.

In all years, when water temperatures exceeded 19 degrees C., survival rates generally decreased. Moreover, the report authors (Muir, et at. 2004) observed that below 19.3 degrees C the survival-temperature relationship was "nearly zero," and above 20.6 degrees C the survival-temperature relationship was "nearly zero." In other words, when temperature changes occurred and crossed a threshold, independent of flow levels, survival levels changed as well. Below or above the threshold level, survival levels were relatively "flat."

This temperature "threshold effect" also was a defining point in another University of Washington study, briefly referenced by the NRC/NAS study, but not given close

[3] NRC/NAS Report pg. 60.

attention. This study, prepared by the Columbia Basin Research Office, UW (Anderson, J., 2004, *A Resolution of the Flow-Survival Debate.* Columbia Basin Research Office, UW, and presentation materials to the NRC/NAS Report authors) observed that the 2001 spring-summer data for migrating chinook salmon through the Lower Snake River to the McNary project displayed a non-linear relationship between flow and survival.

Survival rates actually varied greatly at the same flow levels, when the flow levels were measured during different time periods, with differing temperatures (see Figures 1 and 2 below). For example, during one flow (time) period of about 60 kcfs, survival rates were about 70%, and during another flow (time) period, survival rates were about 20%. The driving factor was temperature, not flow; and *flow was not controlling temperature.*

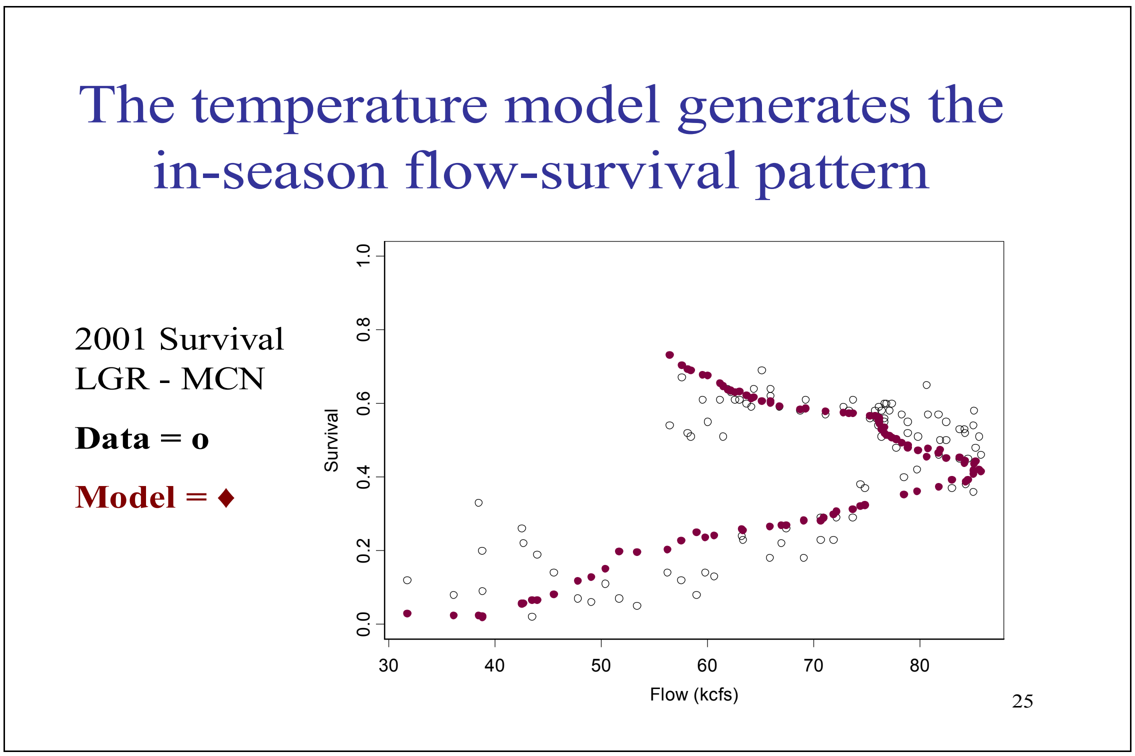

Figure 1.

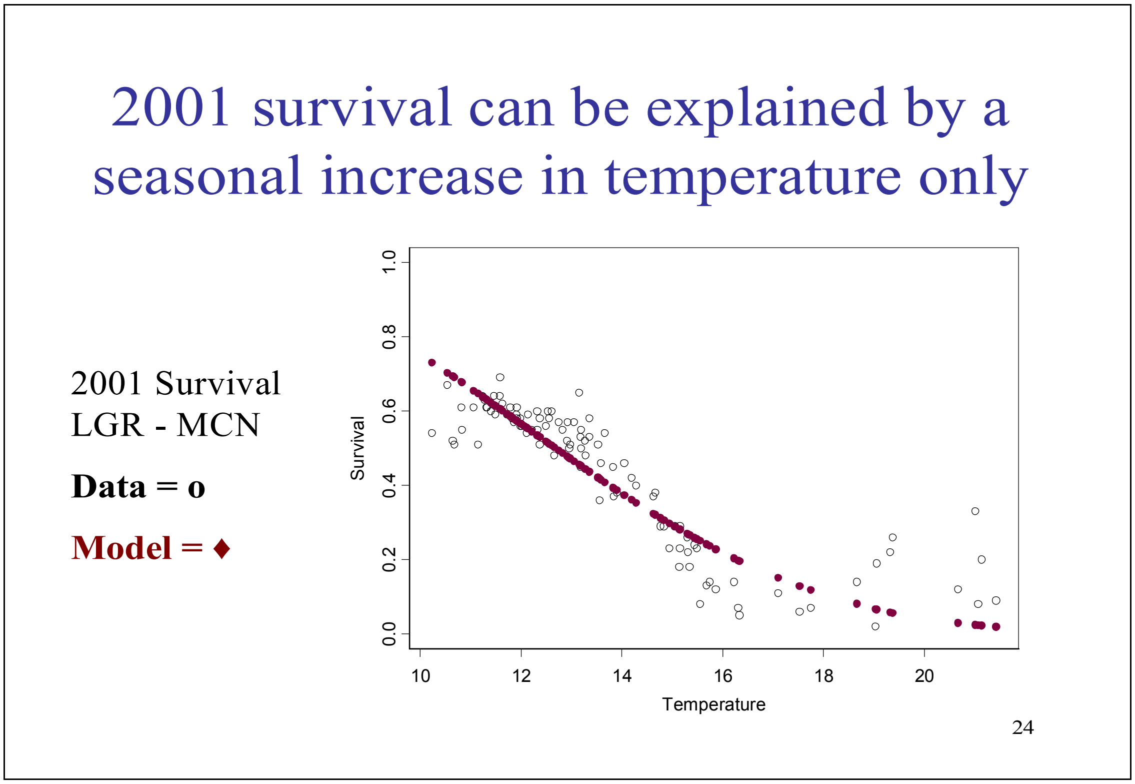

Figure 2.

The data and analyses provided by Muir, et al. (2004) (Report Table 20), also can be reviewed in greater detail regarding statistical significance and explained variance (predictability of the relationship between flow and survival). As noted by the report authors, the flow and survival relationship for the *combined data* may be statistically significant, because of the large sample size involved, but the explanatory power between the variables is relatively low. For example, for the *combined 1999, 2001, and 2002 data* (the year 2000 was omitted from analysis here), an estimated correlation coefficient between flow and survival (r = .506) suggests that the amount of explained variation in survival relative to flows (r^2) is about 0.26 (26%). That is, about 26% of the change in survival levels can be statistically explained by changes to flows—when *multi-year data are combined.* This suggests that other factors—within years--have a much more powerful influence on survival through the pool than flows.[4]

A comparison of the *within-year data* for 2001 (low water year) and 2002 (intermediate water year) gives greater insight into the nature and consistency of the variable relationships. Table 1 below depicts the flow-temperature-travel time and survival data

[4] There are two important problems affecting the interpretation of combined year data for water (fish) management operations. First, the different years, with many different environmental conditions and variables, actual represent distinct sample populations. Combining data from distinct sample populations within a statistical analysis will provide misleading results. Data must be from the same sample population. And second, actual water management operations can only affect within year conditions—flow regime changes only affect a single, within-year situation, not water-fish-temperature-flow conditions across multiple years.

for 2001 (low flow year), for an analysis sample of migrating fall chinook through the John Day Pool (Muir, et al. 2004).

Table 1. 2001 John Day Pool Fall Chinook Survival

Year	Study Group Release Date (End)	McNary/ J.D. Flow (kcfs)	McNary Temperature (Degrees C)	Estimated Temperature Gain Between McN-J.D. (Degrees C)	Travel Time (Days)	Survival Rate (%)
2001	June 25	125/89	16.9	2.4	13.8	.57
2001	July 02	117/80	17.6	3.0	27.6	.56
2001	July 09	92/85	19.2	1.9	26.9	.52
2001	July 16	81/79	20.5	0.2	16.6	.65
2001	July 23	82/84	20.4	0.6	13.7	.59
2001	July 30	82/91	21.4	0.1	13.3	.60

In 2001, the flow and travel time rates fluctuated across the fish release groups, producing mixed results. The lowest flow period (81 kcfs) corresponded to the highest survival rate of .65, while the highest flow period (125 kcfs) corresponded to one of the lower survival rates of .57. The travel times across this flow regime generally decreased, with the decreasing flows.

Table 2 below depicts the flow-survival-temperature-travel time data for 2002 (intermediate water year), for an analysis sample of migrating fall chinook through the John Day Pool (Muir 2004).

Table 2. 2002 John Day Pool Fall Chinook Survival

Year	Study Group Release Date (End)	McNary/ J.D. Flow (kcfs)	McNary Temperature (Degrees C)	Estimated Temperature Gain Between McN-J.D. (Degrees C)	Travel Time (Days)	Survival Rate (%)
2002	June 25	326/309	15.7	1.2	3.8	.89
2002	July 02	322/271	17.0	0.6	4.6	.94
2002	July 09	262/252	16.8	1.4	5.2	.68
2002	July 16	240/226	18.7	0.3	5.0	.81
2002	July 23	229/186	19.7	1.0	4.8	.60
2002	July 30	173/161	20.1	0.6	7.7	.66
2002	Aug 06	160/153	20.2	1.1	8.7	.81
2002	Aug 13	157/146	20.1	1.0	5.6	.45
2002	Aug 20	144/150	21.0	0.0	4.9	.57

In 2002, data were collected over a more extended period of time than in previous years, adding the month of August.

In the latter half of July and through August, the temperatures moved above 19 degrees C. It is noticeable that a large degree of variation in the flows ranging from 229 to 144 kcfs produced mixed results related to travel time and survival; across this flow regime, travel time fluctuated from 4.8 days (229 kcfs) to a high of 8.7 days (160 kcfs), and then back down to 4.9 days (144 kcfs). The survival rate varied as well, but the highest rate of survival (.81) corresponded to the peak travel time for the period (8.7 days), while the lowest survival rate (.45) occurred at a travel time of 5.6 days. Here, there does not appear to be a consistent relationship between travel time and survival.

The above 2001 and 2002 data for *within-year observations* confirm that it is difficult, if not impossible, to relate changes in survival arising from changes in flow or travel time.

Empirical Science Implications for Water Management:

The above data and analyses have important implications for state water management proposals targeting fall chinook (summer period runs) survival in the mainstem Columbia River. This applies most specifically to a low water-year condition like 2001, and during a peak water withdrawal period, such as the months of July and August.

The following conclusions are derived from the empirical data and analyses depicted above but not fully, or adequately, considered by the NRC/NAS study:

- One estimate of water needed for new water rights represents about 250,000 acre-ft., or about 1 kcfs during the peak irrigation withdrawal period during the month of July (57,500 acre-ft.). A 1 kcfs change to flows will have absolutely no significant (or likely empirical impact) on either temperature or fish survival.

- Under the state's December, 2004, Columbia River Initiative (CRI) proposal, the "no net loss plus" multiplier of 1.5 dictated that if 500,000 acre-ft. were withdrawn from the river, then 750,000 acre-ft. would have to be "returned" (750,000 acre-ft. of water shifted to the July-August summer period). If the full 750,000 acre-ft. of water were shifted to these months, not taking into account any actual net withdrawals, the "shifted" flow would be about 6.3 kcfs.

- Even under a "gross" increase of 6.3 kcfs, there would be no significant (or likely empirically measurable impact) on either temperature or fish survival.

- If about 40% of the 750,000 acre-ft. of the water "shifted" was used for irrigation water withdrawals in July and August, then about 450,000 acre-ft. of water would increase flows by about 4 kcfs (net increase). There would be no significant (or likely empirically measurable impact) on either temperature or fish survival.

- The state's proposal to shift initially about 100,000 acre-ft. of water within the Grand Coulee Project to the month of August would increase flows by about 1.7 kcfs. There would be no significant (or likely empirically measurable impact) on either temperature or fish survival.

- It will not be possible to control temperatures in the mainstem Columbia River—and thus fish survival--with the flow regime changes contemplated by the state. It is unlikely that any potential flow regime change would have a meaningful impact.

The implications of the Empirical Science are: 1) small, incremental water withdrawals for new mainstem water rights (250,000 acre-ft.) would have no "measurable" affect on temperature or fish survival; 2) the state's "no net loss plus" proposal would have no measurable affect on temperature or fish survival; and 3) state funds allocated to implement the "no net loss plus" proposal would produce no empirically "measurable" fish benefits.

Stated succinctly, state funding used to shift more water into the July-August period for the mainstem Columbia River will have no empirically measurable fish benefits. To the extent that state funding for fish projects is limited, the state dollars spent on the Columbia River will lead to fewer dollars available for other fish—and water--projects that may yield more tangible benefits elsewhere.

Failure to acknowledge the ghost haunting the NRC/NAS report will invoke a price.