Comparison of Mainstem Recovery Options Recover-1 and DFOP

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Introduction

This document compares two competing mainstem survival options: one based on fish transportation and one that uses reservoir drawdown. The analysis considers spring/summer and fall chinook. The transportation option is based on Recover 1, detailed by Olsen and Anderson (1994). It is similar to Option 1 in the proposed Amendments to the 1994 Columbia River Basis Fish and Wildlife Program. The drawdown option contains elements of Option 5 in the Amendments and the Detailed Fishery Operating Plan advanced in several forms by state fishery agencies and Native American Tribes. For the present document these options are designated Recover 1 and DFOP.

Each option is described along with the survival contributions of the individual components. The analysis used the passage model CRiSP1.5 and population trends were analyzed with the life cycle model, SLCMc. Since conclusions from this comparison depend on the mainstem passage model, the data sets used to calibrate and validate CRiSP1.5 are also discussed.

Results

The results are clear. Using the best available information, the analysis indicates that only a fish transportation option has a chance of recovering endangered chinook salmon. Options which rely on drawdown will *decrease* the populations. Drawdowns to spillway crest will lower spring chinook survival to three-fourths of its current level and fall chinook to one-third of its current level. Even drawdowns to a natural river do not give survivals equal to the current levels. The life cycle analysis suggests that a full transportation program should significantly increase spring chinook and stabilize the decline in fall chinook. For either species, any drawdown option will hasten the population's decline and for fall chinook drawdown may produce rapid extinction.

This analysis with CRiSP1.5 contradicts the Mundy report on transportation (1994) which suggested that transportation alone will not save the salmon populations. The Mundy report applied in-river survival information generated prior to 1992 and applied the flawed Sims and Ossiander survival studies. In the past year, over four man-years of effort have gone into the development, calibration and validation of CRiSP1.5. Through this effort we have significantly revised and improved our understanding of the efficacy of transportation. We have developed a consistent and rigorous picture in which fish transportation is the single most effective action that can be taken to improve the chance of smolt survival. Our conclusions are independent of, but in accord with, NMFS researchers.

Recover 1 Option

Recover 1, which is similar to the Option 1 of the NPPC, was proposed by the Columbia River Alliance (Olsen and Anderson 1994). The strategy is to maximize the benefits of transportation by implementing actions related to flow, fish collection, predator control, and the transportation process itself (Fig. 1).

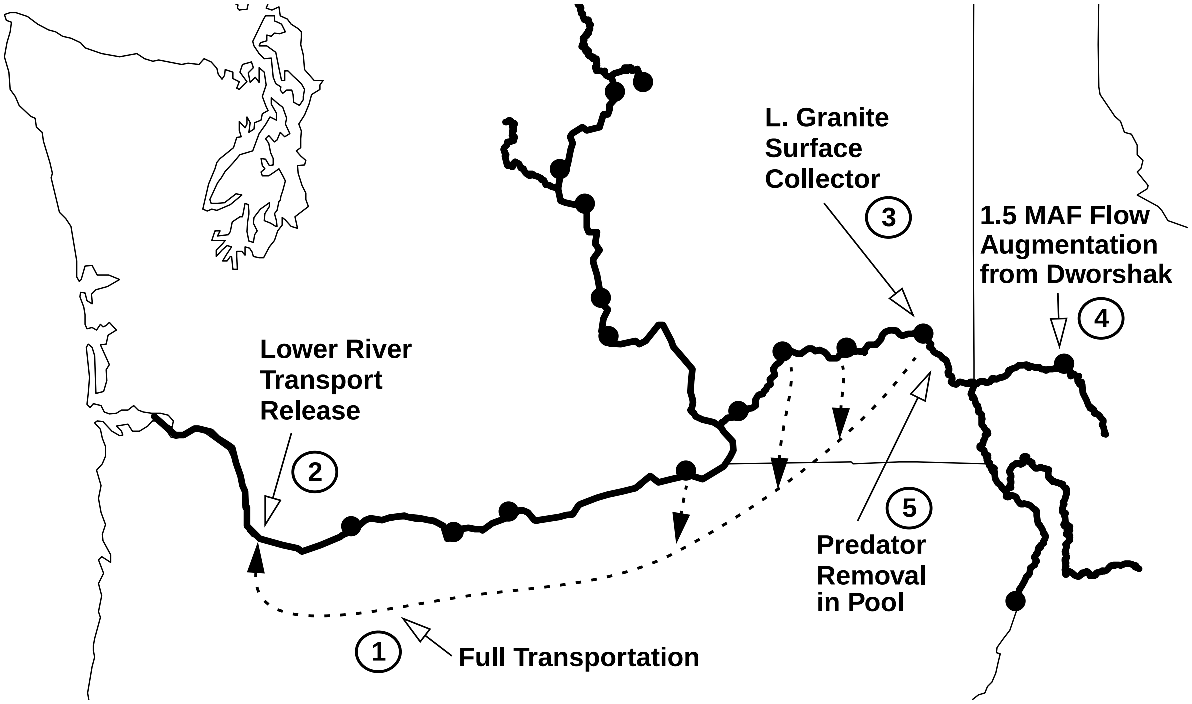


Fig. 1 Recover 1 actions include: 1) Transportation from Snake River dams, 2) Lower river transport release, 3) Surface collectors at transport dams, 4) Flow augmentation from Dworshak Reservoir, 5) Predator removal form Lower Granite Reservoir.

Features of Recover 1

- 1) Full transportation at 4 dams: Lower Granite, Little Goose, Lower Monumental and McNary, with no spill at transport dams.
- 2) Reduce predators in Lower Granite reservoir to 50% of current density.
- 3) During fish residence in Lower Granite reservoir input 22 kcfs flow from Dworshak reservoir for a total added volume 1.5 MAF.
- 4) Install surface collectors at Lower Granite dam
- 5) Improved transportation survival by releasing fish further down river.

Contributions of actions

The actions in Recover 1 were modeled with CRiSP1.5. They are incremental and complimentary and the greatest benefit is gained from transportation (Fig. 2). Actions 2, 3 and 4 improve fish survival to the transportation site. The final measure, moving the transportation release site downstream, improves the net benefit of transportation. Total system survival of spring chinook under Recover 1 was 70% using temperature and flow conditions for 1993. The total fall chinook survival was 51%. In the present configuration, under 1993 conditions, spring and fall chinook survivals were 50% and 35% respectively.

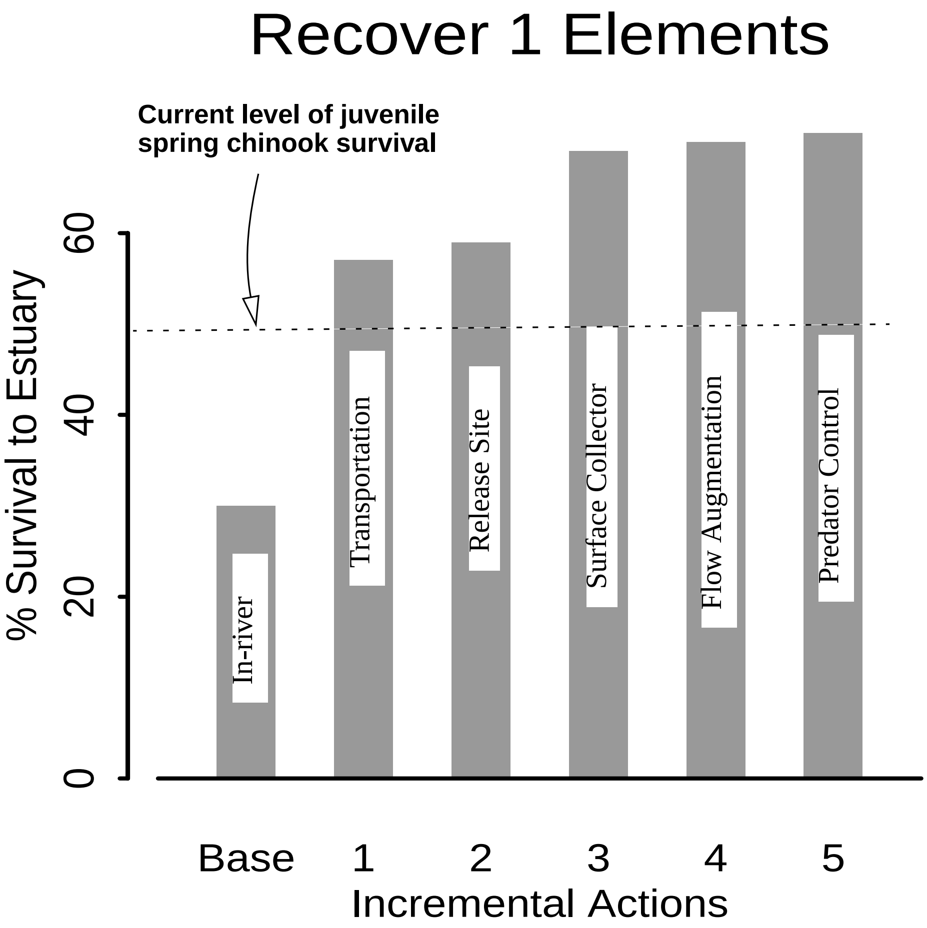


Fig. 2 Incremental effect on juvenile spring chinook survival of the actions in Recover 1. Base is fish passage in-river survival from the top of Lower Granite pool to the estuary. The incremental Actions are 1) transportation, 2) move transportation release site downstream, 3) improve fish collection using surface collectors, 4) flow augmentation, 5) predator removal from Lower Granite reservoir. System survival under current operating conditions is also illustrated.

Life cycle model results

Simulated population levels of adult female spring and fall chinook are illustrated in Fig. 3 and Fig. 4. The projections were generated with the Stochastic Life Cycle Model re-written for a SPARCstation (SLCMc). The model was calibrated from the 1994 Biological Assessment for operation of the Federal Columbia River Power System. This calibration used CRiSP1.4 and to adapt the calibration to CRiSP1.5 the natural ocean mortality coefficient for spring chinook was lowered from 0.03 to 0.023 to reflect the upwards adjustment of in-river survival in CRiSP1.5 compared to CRiSP1.4. Using the 70% system survival computed for Recover 1 the population trend was upwards. The fall chinook life cycle analysis indicated the population was stable under Recover 1. For recovery of fall chinook in particular other actions outside the hydrosystem would be required. The life cycle model calibration used data from the past decade in which ocean conditions were unfavorable to Columbia River salmon survival. If ocean conditions improve stock recovery could be significantly greater.

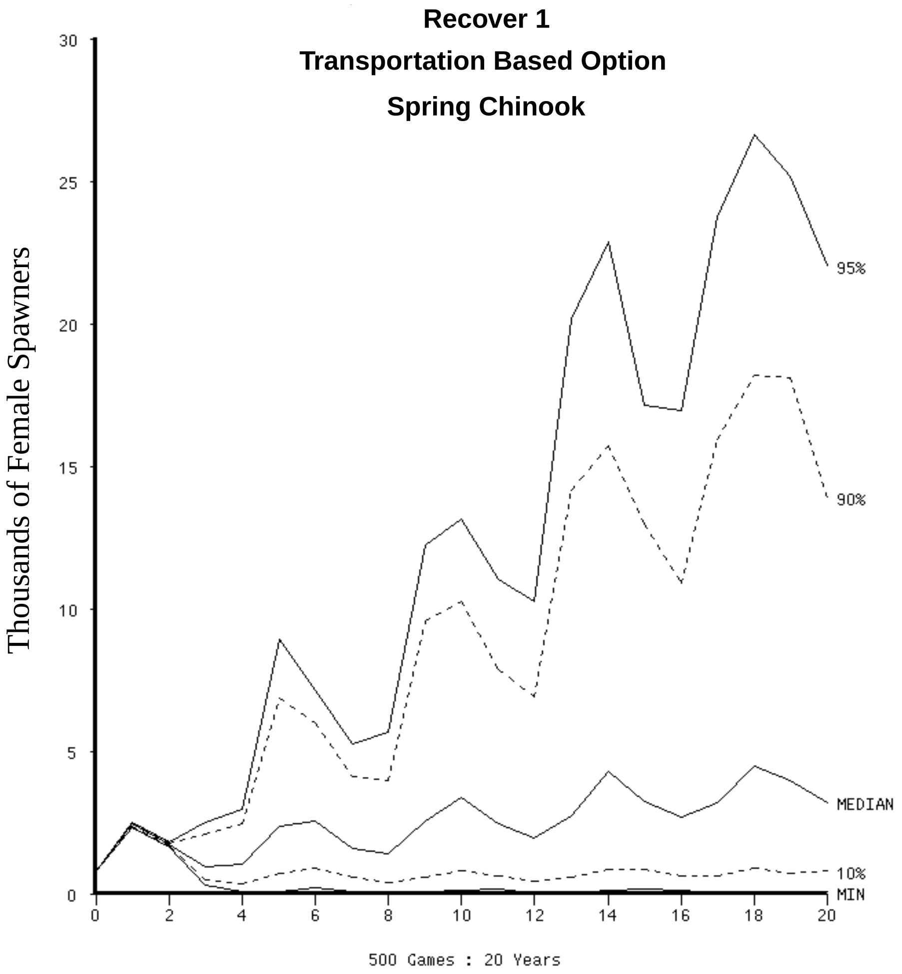


Fig. 3 SLCMc results showing probability percentiles of adult spawning spring chinook females with the Recover 1 option. Stock trend is upwards with the median increasing from under 1000 adult females to 4000 over a 20 year period.

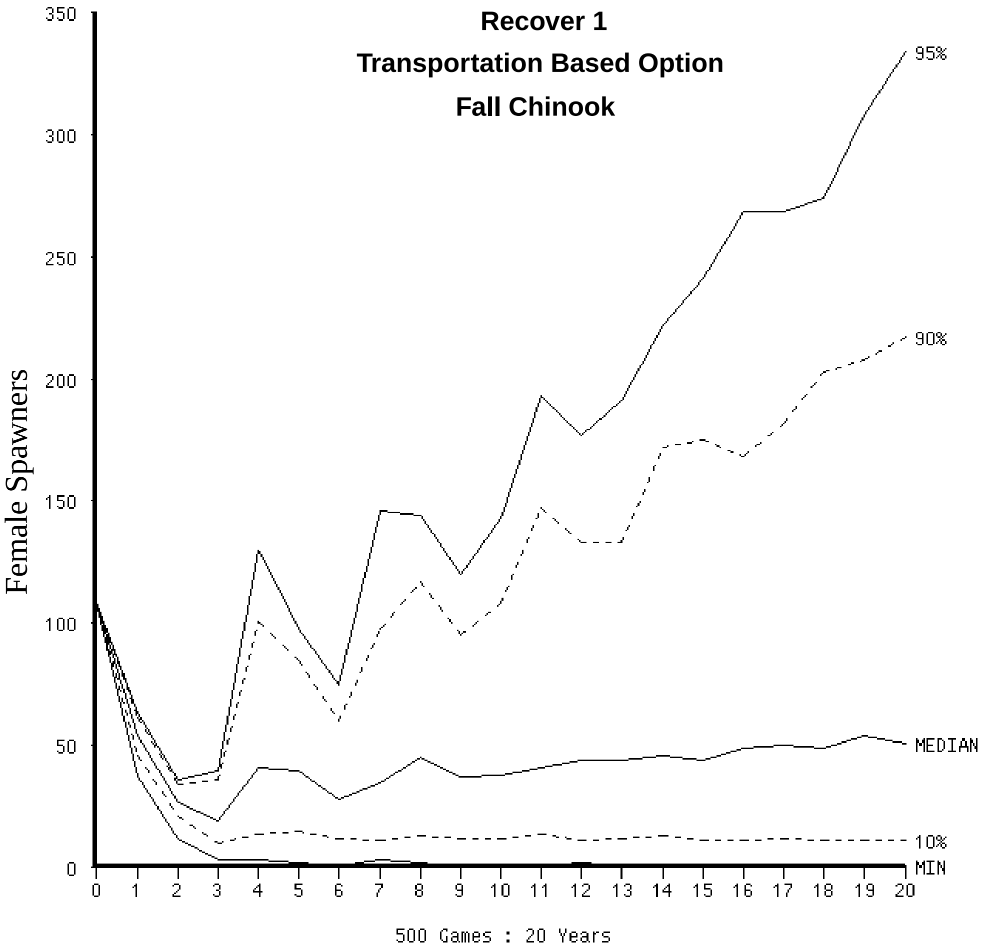


Fig. 4 SLCMc results showing probability percentiles of adult spawning fall chinook females with Recover 1. Stock trend is steady with the median eventually increasing to 50 fish over a 20 year period.

DFOP Option

A DFOP type action was analyzed with CRiSP1.5 and SLCMc. The actions affects on mainstem system survival are illustrated in Fig. 5. Two versions of DFOP were analyzed: a drawdown to spillway crest behind Snake River dams, and a drawdown to natural river conditions behind Snake River dams. In addition, John Day reservoir was lowered to minimum operating pool (MOP). Spill in the lower river was 80% Fish Passage Efficiency (FPE) and nitrogen supersaturation did not exceed 120%. In the natural river condition the Snake River dams had no spill.

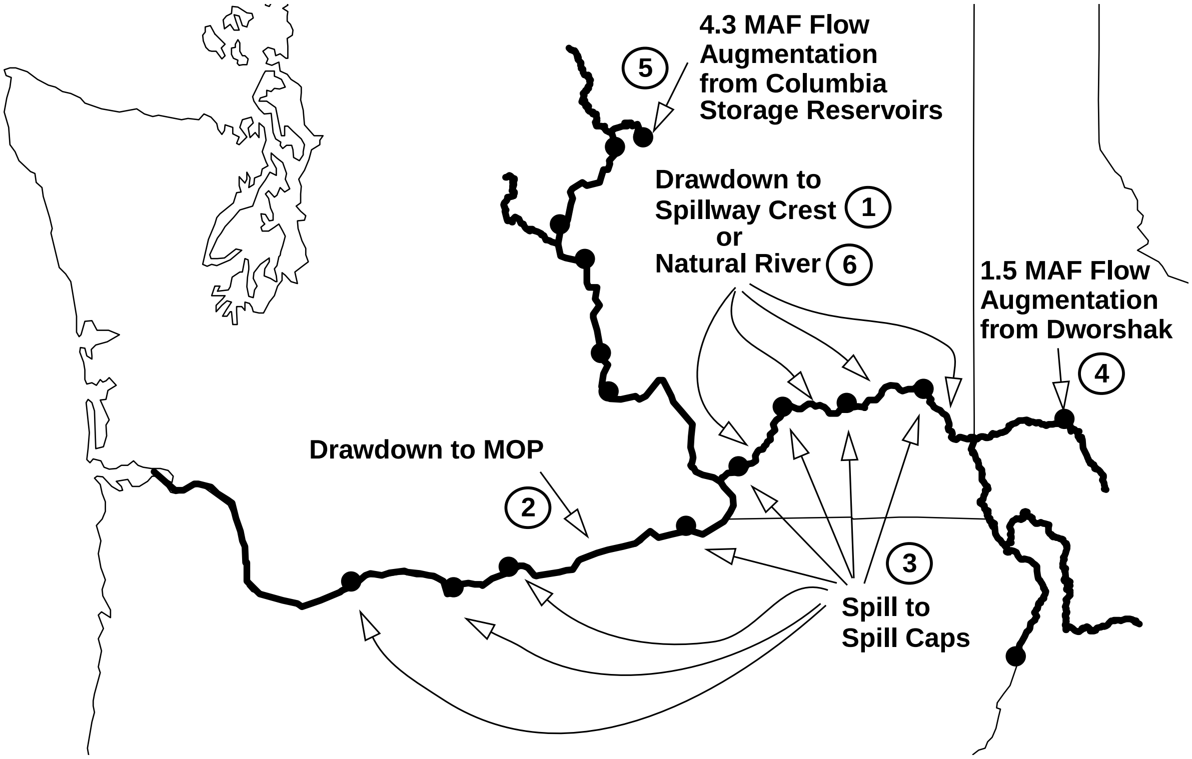


Fig. 5 Locations and descriptions of actions with DFOP type options. Action include: 1) drawdown of Snake River dams to spillway crest or to natural river conditions, 2) drawdown of John Day Reservoir to minimum operating pool, 3) spill to 80% FPE, 4) 1.5 MAF flow augmentation from Dworshak reservoir and, 5) 4.3 MAF flow augmentation from Columbia reservoirs.

Contributions of actions

The incremental effect of drawdown by itself decreased survival from the in-river base condition because bypass systems were inoperative and more fish passed through turbines. Additional drawdown in John Day reservoir had no significant impact on survival. Spill was required with drawdown to decrease turbine passage. Flow augmentation from Dworshak and the Columbia storage reservoirs increased total system survival by 1% for spring chinook. This increase may be even lower since the mainstem passage models do not account for mortality associated with the longer estuary/ocean residence which is a consequence of a shorter river residence (Anderson and Hinrichsen 1994). Finally, a drawdown to natural river conditions in the Snake River returned survival to near the level of the present system for spring chinook. The spring chinook system survival with spillway crest drawdowns was 38% and with the natural river drawdown it was 45%. For comparison, the current spring chinook system survival is calculated to be about 50%.

The fall chinook exhibited a worse response to drawdown options. System survival with the spillway crest drawdown was 12% and with the natural river drawdown it was 16%. For comparison, the current system survival of fall chinook is estimated to be 35%. Flow augmentation had no affect on fall chinook survival. Temperature and flow conditions for 1993 were used in the model runs.

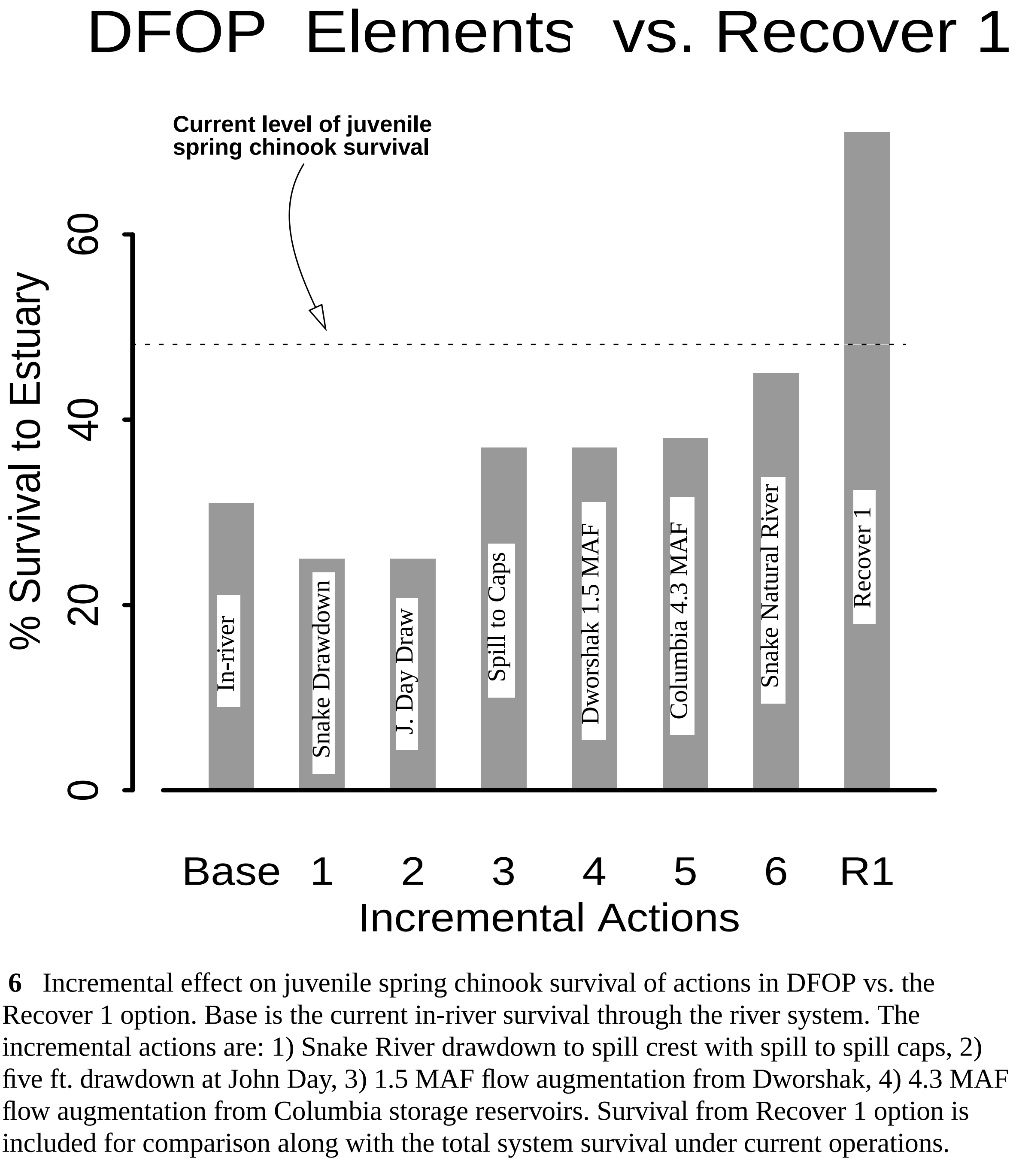


Fig. 6 Incremental effect on juvenile spring chinook survival of actions in DFOP vs. the Recover 1 option. Base is the current in-river survival through the river system. The incremental actions are: 1) Snake River drawdown to spill crest with spill to spill caps, 2) five ft. drawdown at John Day, 3) 1.5 MAF flow augmentation from Dworshak, 4) 4.3 MAF flow augmentation from Columbia storage reservoirs. Survival from Recover 1 option is included for comparison along with the total system survival under current operations.

Life cycle results for DFOP

Spring chinook life cycle models runs were conducted for hydrosystem survivals of 38% (the spillway crest option) and 45% (the natural river option). In the spillway crest option (Fig. 7) in-river survival was lower than under present conditions and the population trend was *downward*. With the natural river option (Fig. 8) system survival was similar to current conditions and the trend was downward.

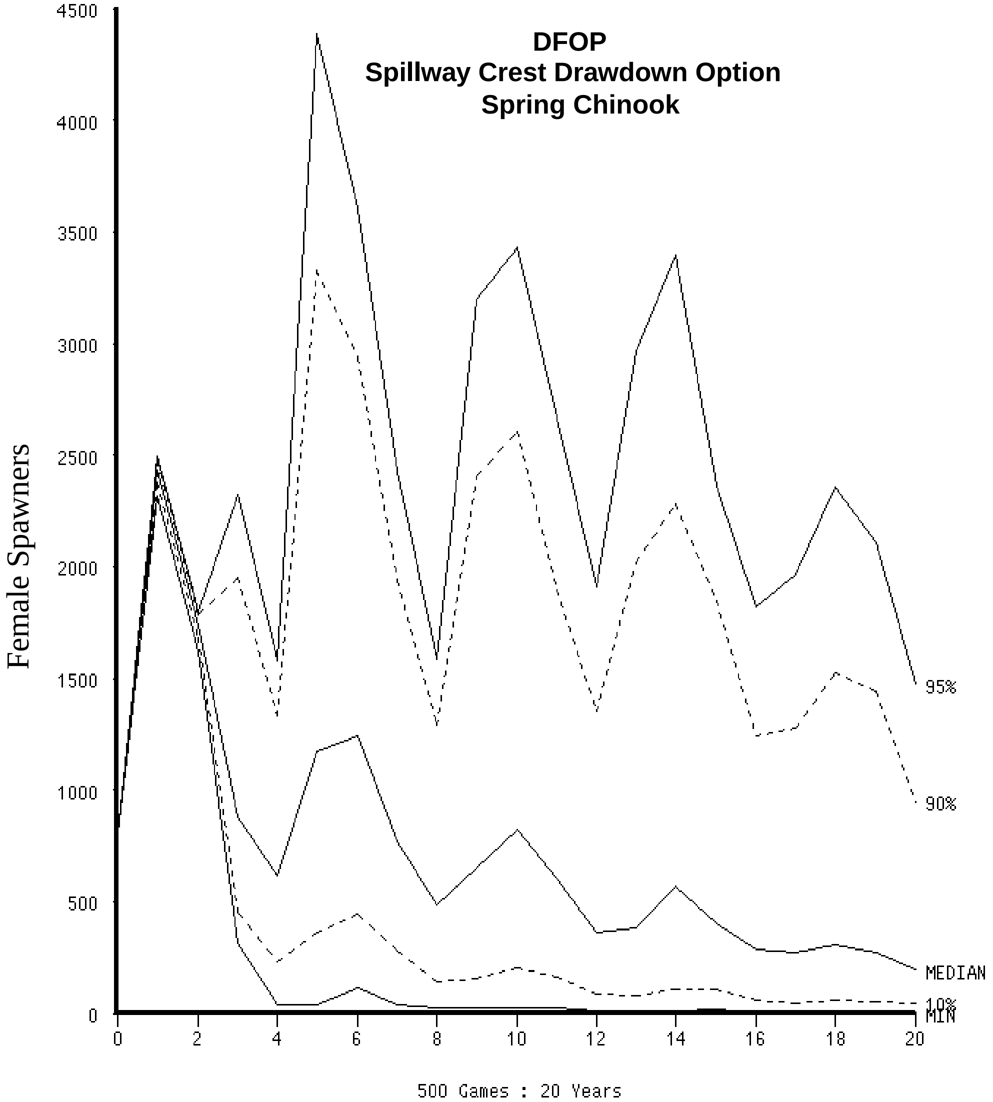


Fig. 7 SLCMc results showing probability percentiles of adult spawning spring chinook females with the drawdown to spillway crest DFOP option. Stock trend is downwards with the median decreasing from under 1000 adult females to about 200 over a 20 year period.

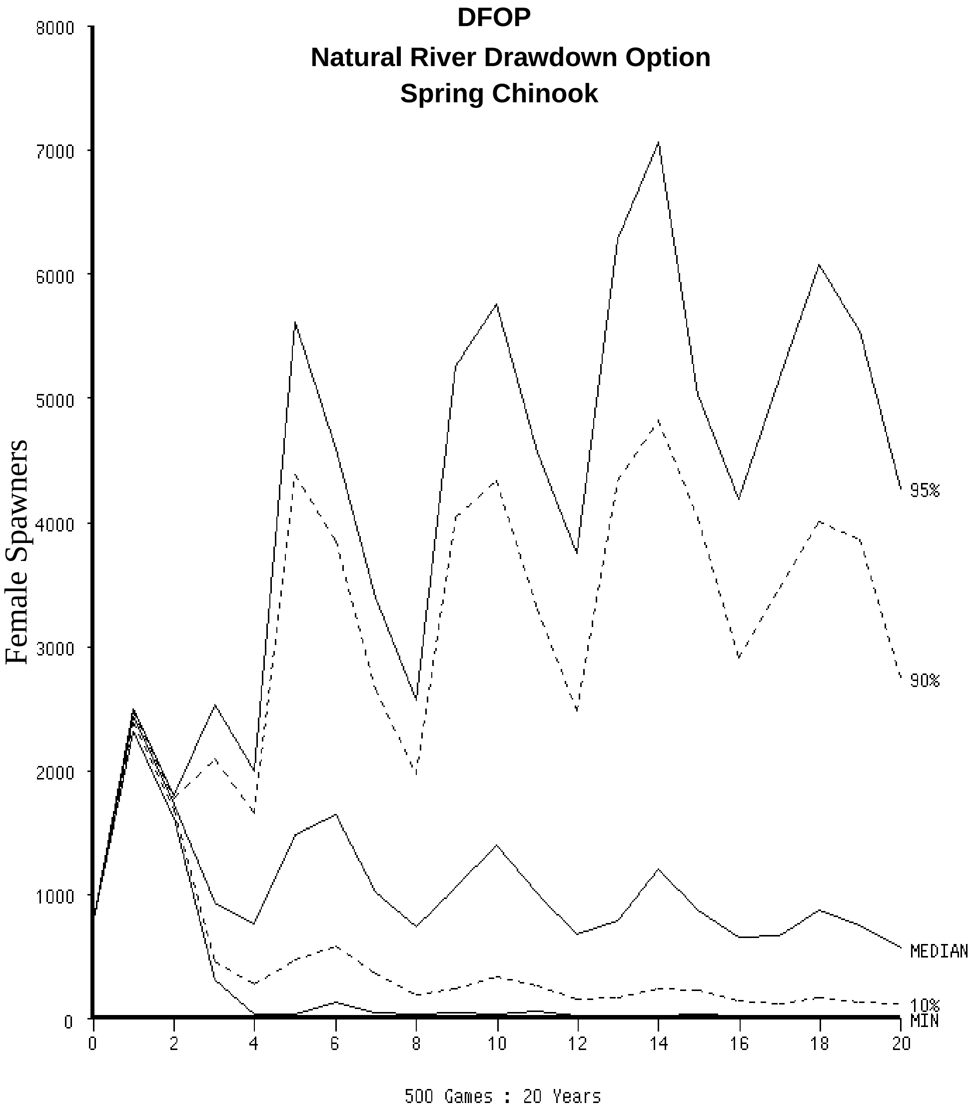


Fig. 8 SLCMc results showing probability percentiles of adult spawning spring chinook females with the drawdown to natural river level DFOP option. Stock trend is downwards with the median decreasing from under 1000 adult females to about 500 over a 20 year period.

Fall chinook, life cycle models runs were conducted for hydrosystem survivals of 16%, representing the natural river DFOP option. Under this natural river option (Fig. 9) the population trend was sharply downward to extinction. The decline was more rapid for the spillway crest option.

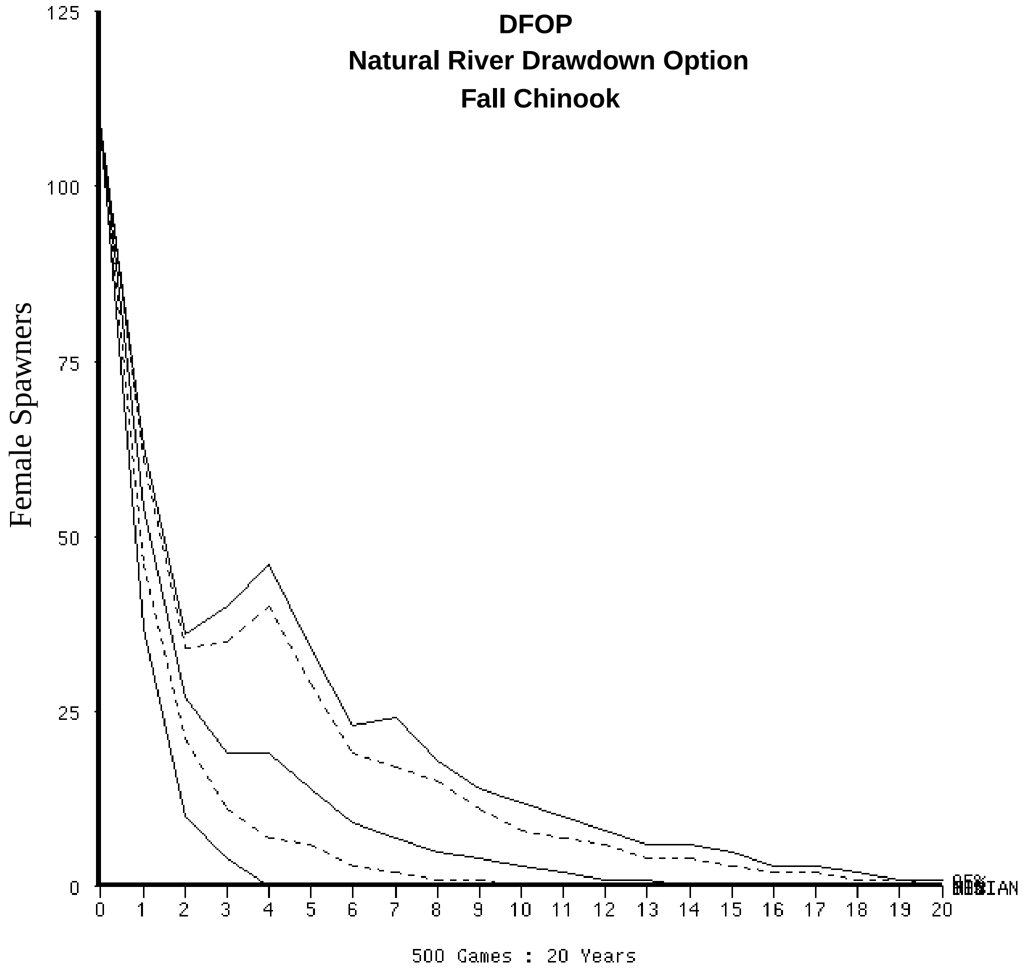


Fig. 9 SLCMc results showing probability percentiles of adult spawning fall chinook females under the drawdown to natural river level DFOP option. Stock trend is downwards to extinction.

Model Calibration

The predictions on mainstem survival for Recover-1 and DFOP are based on the most recent calibration and modifications of CRiSP1. This model, the newest version designated CRiSP1.5, received extensive development, calibration and validation over the past year. Over four man-years have gone into CRiSP1.5 alone. This is in addition to the fifteen man-years in developing the model up through CRiSP1.4. Through this effort CRiSP1 has evolved into a powerful modeling system that is consistent for a wide range of data for both spring/summer and fall chinook.

Calibration

CRiSP1.5 has been calibrated with independent data sets that extend over the entire Columbia and Snake River system (Fig. 10). Essential elements of the calibration are as follows:

- ① Predator activity coefficients to quantify spring and fall chinook reservoir mortality rates were calibration with 1984-1986 John Day reservoir predator studies.
- ② Snake River fish guidance efficiency (FGE) was calibrated with PIT tag data from the Snake River dams between 1989 and 1993.
- ③ Fish migration behavior was calibrated with PIT tag and brand release data in the mid-Columbia and Snake River systems.
- ④ Spill generated supersaturation was calibrated with Army Corps nitrogen data including data from the 1994 spring spills.
- Gas bubble disease (GBD) was calibrated with Dawley et al. (1976) and Fidler (1981) data. GBD threshold was 110% supersaturation.
- ④ Predator density information extends through entire river system and was updated with predator index studies through 1993.
- ⑤ Daily temperatures, spill, and flows for years 1975 - 1994 were obtained from the Army Corps (Fig. 11).
- ⑥ Transportation survival was evaluated using CRiSP1.5 in river survival estimates and a reanalysis of the transport benefit ratio (TBR) information. Transport survivals consistent with observed TBRs are 89% for spring and 96% fall chinook.

Validation

The calibrated model was checked by comparing predicted survivals and passage numbers against independent observations not used in the calibration. In effect, the model’s hypotheses on passage and survival were tested against independent data. The validation data sets covered the entire Colombia and Snake River system (Fig. 10). Specific data sets that the model was tested with are listed below and survival comparisons are given in Table 1. The circled numbers identify the location of data sets in Fig. 10. Results of the validation include:

- ① Fits Priest Rapids adult return data as analyzed by Hilborn et al. (1994)
- ② Calibrated FGE agrees with studies based on fyke net and PIT tag collections.
- ③ Predicted reservoir survival fits NMFS Snake River PIT tag survival estimates.
- ④ Predicted fish travel time between dams fits observed data (Fig. 12).
- ⑤ Predicted juvenile wild fall chinook arrival date fits observed data (Fig. 13).
- ⑥ Predicted survivals from Methow to Priest Rapids dam fits observed values.
- ⑦ Fits with results from the later years of Sims and Ossiander survival studies
- ⑧ Model-derived system survivals are sufficient to calibrate spring and fall chinook life cycle models.

Table 1. Comparison of observed and CRiSP predicted survivals and FGEs

	Species	Location	Source of Obs	Date of Obs	Obs	CRiSP
Survival	spring	Methow to PRD	FPC (1988)	1985 - 1987	45%	41%
	fall	Priest Rapids hatchery	Hilborn (1993)	1977-1991	11.3[a]%	18.4[b]%
	spring	LGR reservoir	Iwamoto (1993)	1993	89%	90%
	spring	LGR dam	Iwamoto (1993)	1993	97%	95%
	spring	Snake to JDA	Sims & Ossiander[c]	1978	44%	50%
FGE	spring	LGR dam MCN dam	NMFS FGE studies using fyke nets	1993 1992	45% 60%	45% 60%
	fall	LGR dam MCN dam		various years	35% 47%	35% 40%

a. Survival from Priest Rapids hatchery to entry into fishery
b. Survival from Priest Rapids hatchery to Jones Beach

c. As reported in Steward (1994)

Fig. 10 Locations of data sets used to calibrate and validated CRiSP1.5 Length of river over which data extends is indicated by (——▷) for data used in calibration and (- - - ▷) for data used in validation.

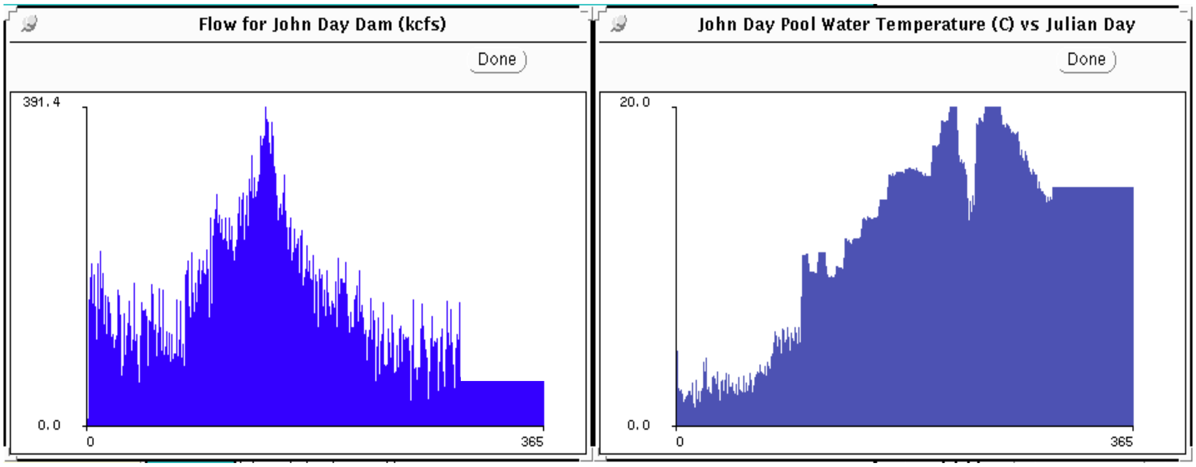
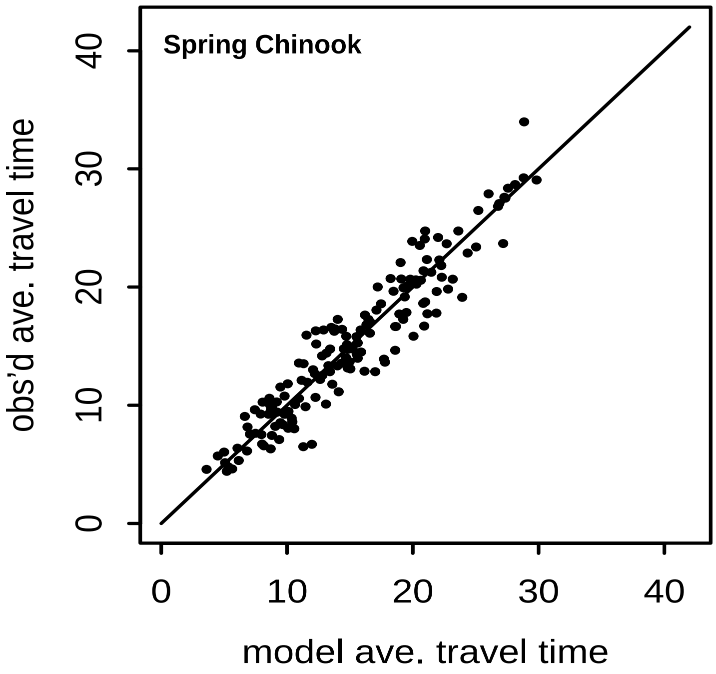


Fig. 11 Examples of flow (kcfs) and temperature (C) vs. Julian day used in CRiSP1.5. The data, obtained from the Army Corps, are for specific years (1975 through 1994) since both variables affect fish migration and survival.



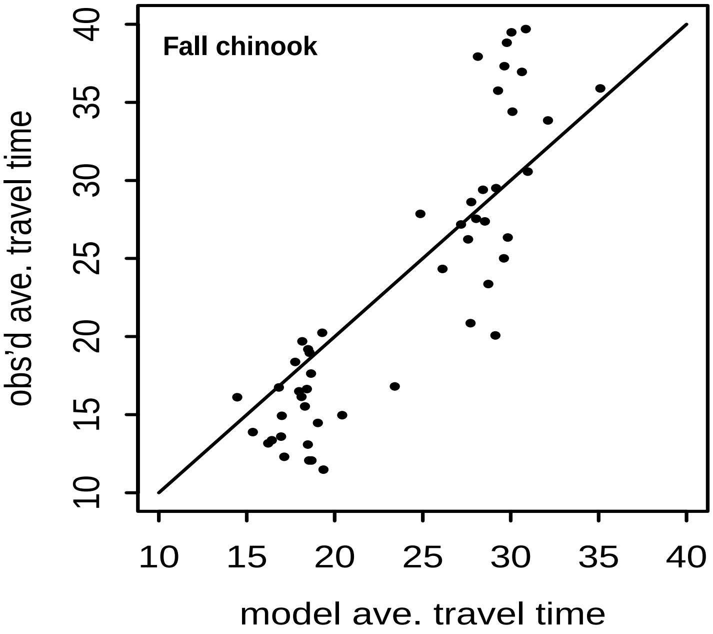


Fig. 12 Spring chinook and fall chinook observed travel time to dams vs. modeled travel time. For spring chinook, data includes travel time to four dams, LGR, LGO, MCN. For fall chinook, Priest Rapids brand releases for the years 1988-1989, 1991-1993 are observed at McNary and John Day dams.

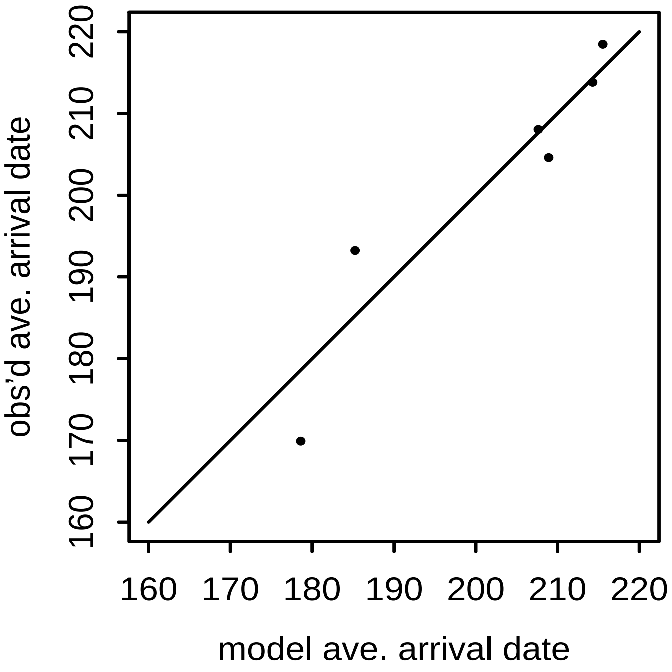


Fig. 13 Observed date of arrival of wild fall chinook to Lower Granite dam to predicted arrival time. Data covers years 1990-1993. This information is used to calibrate the initiation of migration.

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