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Predicting Fish Survival Response through the FCRPS using the SIMPAS Model

NOAA-NWPCC Reservoir Operation/Flow Survival Symposium

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Presentation Overview

- Description of SIMPAS Model
- Development & history of SIMPAS
- How does SIMPAS model work?
- Analytical approach in 2004 BiOp
- Development and use of flow-survival relationships in model
- Survival gap analysis for SR fall chinook

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Description of SIMPAS Model

- SIMPAS is NOAA's "Simulated Fish Passage" spreadsheet model for 8 FCRPS mainstem dams
- Juvenile fish passage accounting model
- Apportions run to various passage routes, i.e., turbines, bypasses, RSWs, spillways, sluiceways, transportation (barges), etc.
- Accounts for both fish survivals & mortalities, at each hydro project and thru entire hydrosystem, plus % fish transported or left in-river

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Development & History of SIMPAS

- SIMPAS model first developed by NOAA-F Hydro to evaluate potential actions for 1995 BiOp
- Model used regularly as analytical tool to evaluate survival differences between various structural or operational alternatives
- In 1999 & 2000, model was used to evaluate the proposed action for 2000 FCRPS BiOp
- Model has been updated to accommodate add'l. passage routes (RSW & surface bypass) & is being used to evaluate proposed action for 2004 BiOp

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How does SIMPAS Work?

- SIMPAS model starts w/group of fish at head of LWG pool & applies a pool survival rate prior to fish reaching dam forebay
- At dam, model assigns surviving fish to various routes of dam passage, applies survival rates to each route of passage & removes transported fish
- It then recombines surviving fish in dam tailrace
- Model repeats this fish accounting (survival) process at each FCRPS mainstem hydro project

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How does SIMPAS Work? (2)

- For each fish species, model inputs include:
  - Seasonal average flows and spills at each dam
  - Spill, sluiceway, RSW & guidance efficiencies
  - Survival rates through various passage routes
- For each species, model output estimates include:
  - Proportion of fish transported and left in-river
  - Project-specific and system survival estimates (with and without a D-value for transported fish)
  - Fish passage efficiency at each dam & system avg.
  - Turbine mortality at each dam & system average

Enter data in BLUE shaded text only. Check the RED TABS for specific instructions.

The model is set up for spring chinook.

- Click the button to print this page.
- Click to setup for yearling chinook.
- Click to setup for subyearling chinook.
- Click to setup for steelhead.

Fish Stock:	Mixed stock spring chinook. 1995 passage year.											
Scenario:	Proposed 2004 Operation.											
Input at head of Lower Granite Pool:	1	Input at mouth of Snake River:			1							
FLOW INPUTS	LGR	LGS	LMN	IHR	SR Mouth	MCN	JDA	TDA		BON		To Salt
FIRST DAILY PERIOD (Typically Night)									Project	PI	PII	
Spill Efficiency	2.7	1.4	1.5	2.7		1.1	1.4	1.7	1.0			
Total Flow	93.6	93.6	93.6	93.6		244.4	244.4	244.4	244.4			
Total Spill Flow	20.0	45.0	40.0	20.0		185.0	146.6	97.8	120.0			
Spill Flow Through Raised Crest	7.0	0.0	0.0	7.0		0.0	0.0	0.0	0.0			
SECOND DAILY PERIOD (Typically Day)												
Spill Efficiency	2.7	0.0	1.5	2.7		1.6	0.0	1.7	1.0			
Total Flow	93.6	93.6	93.6	93.6		244.4	244.4	244.4	244.4			
Total Spill Flow (standard & raised crest bays)	20.0	0.0	40.0	20.0		74.4	0.0	97.8	75.0			
Spill Flow Through Raised Crest	7.0	0.0	0.0	7.0		0.0	0.0	0.0	0.0			
PASSAGE AND SURVIVAL INPUTS												
Diel (% of fish passing during first period spill hours)	0.50	0.68	0.50	0.50		0.50	0.80	0.50	n/a			
FGE (Both Periods)	0.82	0.78	0.49	0.78		0.89	0.73	0.00		0.00	0.48	
Sluiceway or Surface Bypass Collector Efficiency	0.00	0.00	0.00	0.00		0.00	0.00	n/a		0.22	0.46	
Bonneville Data ---------->						PH Priority (PH1=1, PH2=2)			2			
Bonneville Data ---------->						Capped Spill Hours			15			
Turbine Survival	0.93	0.92	0.865	0.89		0.90	0.82	0.84		0.92	0.90	
Spillway Survival	0.98	1.00	0.956	0.96		0.95	0.98	0.96	0.98			
Raised Crest Survival	0.98	0.00	0.00	0.98		0.00	0.00	0.00	0.00			
Bypass Survival	0.98	0.99	0.95	0.98		0.90	0.95				0.98	
Sluiceway or Surface Bypass Collector Survival	0.00	0.00	0.00	0.00		0.00	0.00	0.965		0.92	0.98	
Pool Predation Adjustment Factor	1.00	0.995	1.00	1.00		1.00	1.00	1.00	1.00			1.00
Pool Survival	0.949	0.913	1.000	0.998	1.000	1.000	0.908	0.976	0.925			1.000
GBD Mortality			Snake River Reach		0.00					L. Columbia Reach		0.00
Reach Survival (BON to saltwater for transported fish)												1.00
Transport Survival (in barge)												0.98
D Value for Transported Fish				Hatchery D Value:		0.886	Mixed D Value:		0.000	Wild D Value:		0.553
OUTPUTS	LGR	LGS	LMN	IHR	SR Mouth	MCN	JDA	TDA	BON			System
									Project	PI	PII	Average
Fish Passage Efficiency (FPE)	0.924	0.882	0.814	0.907		0.962	0.905	0.849	0.792			0.879
Daily average spill	0.214	0.240	0.427	0.214		0.531	0.300	0.400	0.376			0.338
First period average spill	0.214	0.481	0.427	0.214		0.757	0.600	0.400	0.491			0.448
Second period average spill	0.214	0.000	0.427	0.214		0.304	0.000	0.400	0.307			0.233
Turbine Passage	0.076	0.118	0.186	0.093		0.038	0.095	0.151	0.208	0.051	0.157	0.121
Bypass Passage (and/or Collection)	0.346	0.419	0.179	0.329		0.305	0.256	0.000	0.145			0.247
Sluiceway Passage	0.000	0.000	0.000	0.000		0.000	0.000	0.184	0.271	0.01	0.26	0.057
Spill Passage (Normal Bays Only)	0.059	0.463	0.635	0.059		0.658	0.649	0.665	0.376			0.445
RSW Passage	0.519	0.000	0.000	0.519		0.000	0.000	n/a	n/a			0.130

TRANSPORT ESTIMATES	LGR	LGS	LMN	IHR	SRM	MCN	JDA	TDA	BON	To Salt Survival			Total To Salt Survival		
										Total	In-River	Transp.	w/D Value Hatchery	w/D Value Mixed	w/D Value Wild
SR pop arriving w/ full transport (LGR, LGS, LMN, MCN)							0.140	0.130	0.114	0.7814	0.1096	0.6718		0.0000	
SR pop arriving w/ 3 collector dams (LGR, LGS, LMN)				0.240	0.233	0.233	0.198	0.185	0.16106	0.7573	0.1552	0.6021	0.6887		0.4882
SR pop arriving w/ 2 collector dams (LGR, LGS)			0.314	0.294	0.285	0.285	0.242	0.226	0.197	0.7366	0.1896	0.5471			
SR pop arriving w/ 1 collector dam (LGR)		0.549													
SR pop collected at...	0.328	0.230	0.056			0.071									
Cumulative SR pop collected	0.328	0.558	0.614			0.685									
Mid-C pop arriving w/ collection at MCN							0.598	0.559	0.487	0.7681	0.4697	0.2984			
Mid-C pop collected at...						0.305									

INRIVER SURVIVAL ESTIMATES	LGR	LGS	LMN	IHR	SRM	MCN	JDA	TDA	BON	To Salt	Average	Cumulative
Dam plus Pool Survival (Project Survival)	0.926	0.896	0.938	0.968		0.933	0.869	0.920	0.891		0.9177	
Dam Survival	0.9762	0.9864	0.9380	0.9705		0.9329	0.9571	0.9428	0.9635		0.9584	0.7110
Turbine Mortality at Individual Dams	0.005	0.009	0.025	0.010		0.004	0.017	0.024	0.020		0.0144	
Cumulative Survival w/o transport (SR Stocks)	0.949	0.841	0.830	0.776	0.753	0.753	0.638	0.596	0.520	0.5011		
Cumulative Survival w/o transport (Mid-C Stocks)					1.000	1.000	0.847	0.792	0.690	0.6651		
To Salt Survival From Head Of Each Pool w/o transport						0.665	0.713	0.820	0.891			

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Analytical Approach for 2004 BiOp

- Est. the effects attributable to envir. baseline (hydro) compared to effects of Proposed Action--Gap analysis
- Establish a reference operation (R.O.) to describe the "best" survival rate associated w/existing config. of dams & reservoirs over 1994 to 2003 study period
- Evaluate est'd. survival rate associated with Action Agencies' updated Proposed Action (P.A.)
- Compare the est'd. system survival rates between the P.A. and reference operations to obtain a relative difference in survival for each species

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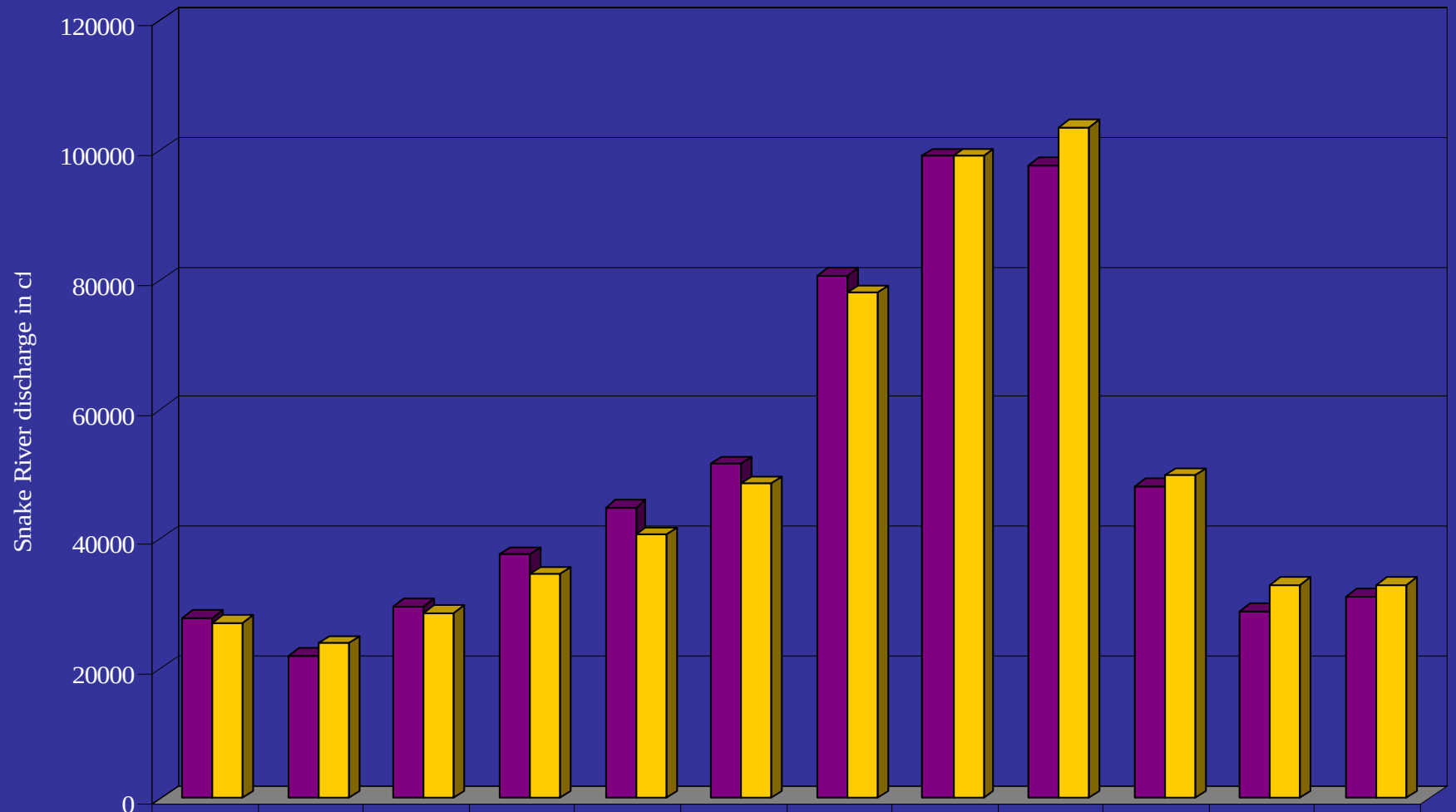
Analytical Approach for 2004 BiOp

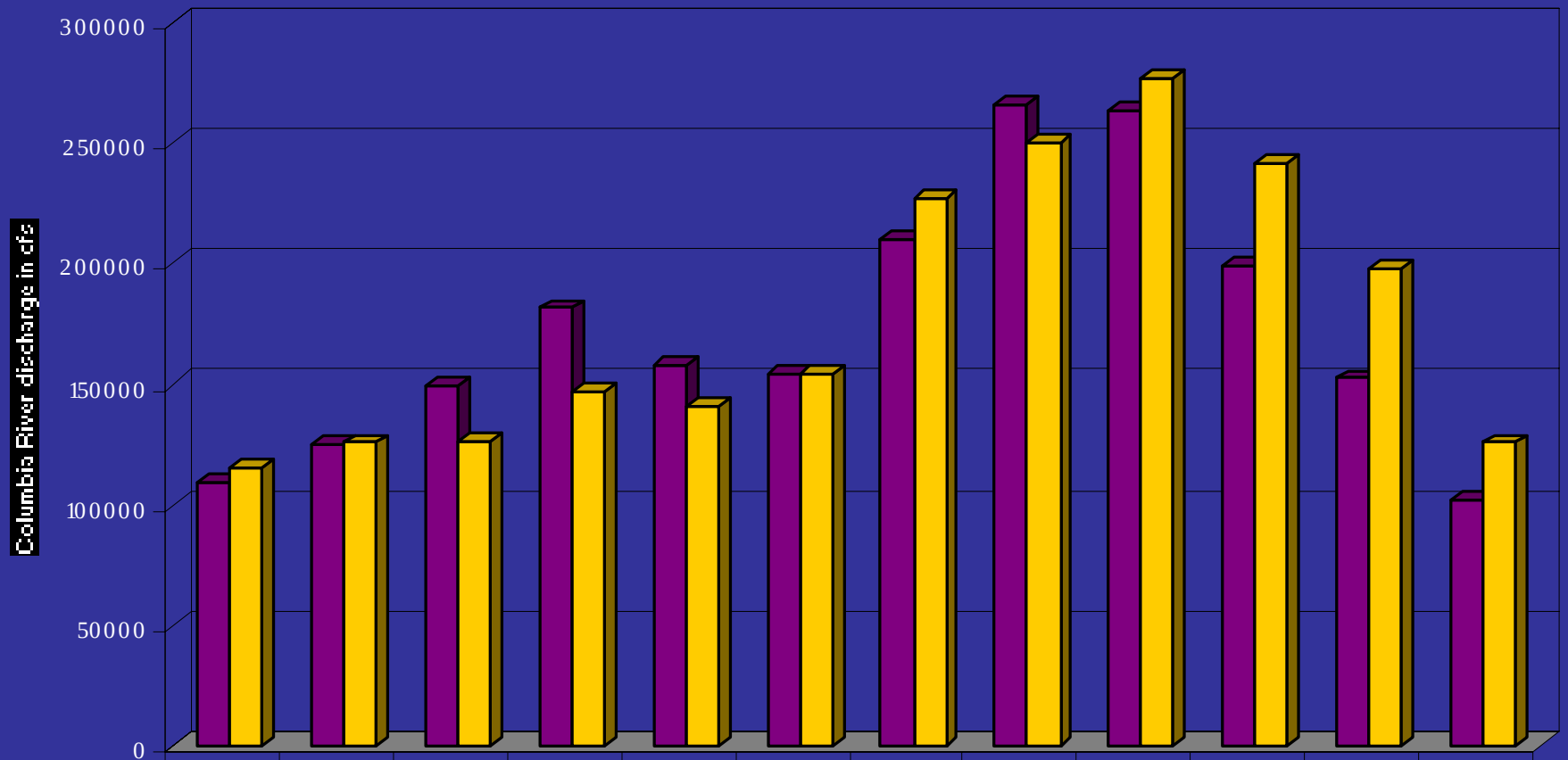
- Differences between R.O. and P.A. operations:
- Seasonal avg summer flows for two operations from BPA's 50-year HYDSIM hydroregulation model
- In R.O., FCRPS storage reservoirs used fully to meet slightly higher summer flow objectives
- P.A. used 2000 BiOp flow objectives and draft limits
- For R.O., exceedance prob. of meeting 2000 BiOp flow objectives at LWG & MCN was 10% and 78%
- For P.A., exceedance prob. of meeting 2000 BiOp flow objectives at LWG & MCN was 10% and 36%

Mean Monthly Snake River Discharge at Lower Granite Dam



	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Proposed Action	27800	22000	29600	37600	44900	51600	80700	99100	97700	48200	28900	31200
Reference Operation	27100	23900	28600	34600	40700	48500	78000	99200	103600	49800	32900	32900

Mean Monthly Columbia River Discharge at McNary Dam



	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Proposed Action	109600	125000	148900	181500	157800	154200	210200	266100	263800	198900	152400	101600
Reference Operation	115900	125700	126700	147400	141000	154000	226600	249900	276600	241700	198100	125787

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Analytical Approach for 2004 BiOp

- Differences between R.O. & P.A. operations (2):
- No differences assumed between R.O. and P.A. summer transport operations, i.e., no spill at collector dams & all fish collected are transported from LWG, LGS, LMN and MCN dams.
- At 4 non-collector dams, R.O. assumes 24-hour spill and at higher levels than P.A. at JDA & BON

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Development & Use of Flow-Survival Relationships

- Three major steps necessary to complete survival gap estimates between R.O. & P.A. using SIMPAS
- Step 1: Define and evaluate a retrospective analysis of survivals over 1994-2003 study period
- This step needed to define functional relationship between flow and survival during 10-year period
- Model was calibrated to NWFSC empirical reach survival rates using *actual* seasonal average flow/spill data and fish passage parameters at each dam for each year

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Development & Use of Flow-Survival Relationships (2)

Step 1 cont'd: 1994-2003 retrospective analysis

- After calibration of model to empirical reach survival data, individual pool survivals were derived from reach survivals by removing dam survivals
- Lower Snake pool survivals based on 5 years of empirical reach survivals for SR fall chinook
- Lower Columbia pool survivals based on extrapolating empirical reach survival data from Snake River based on per-mile expansion method

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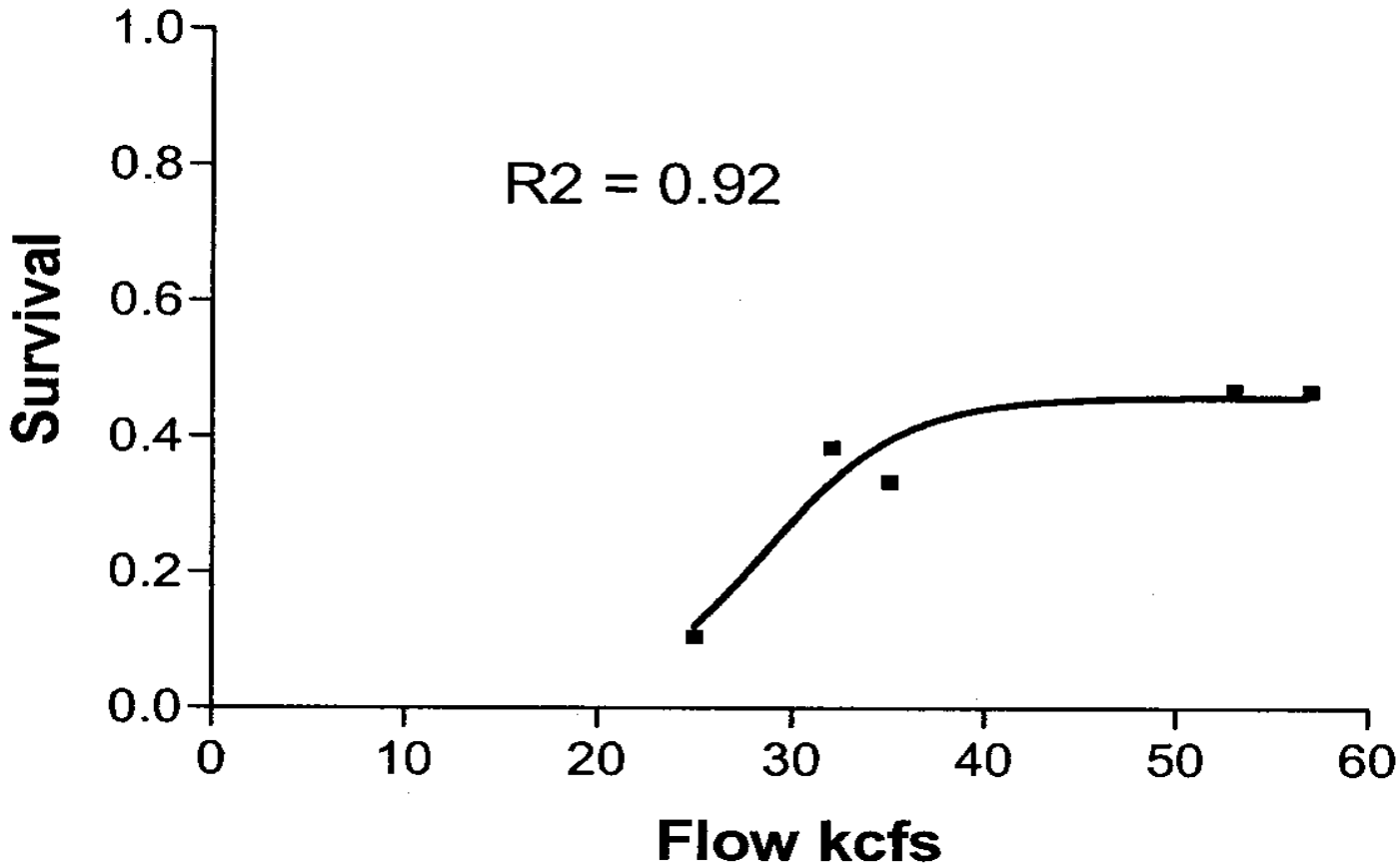
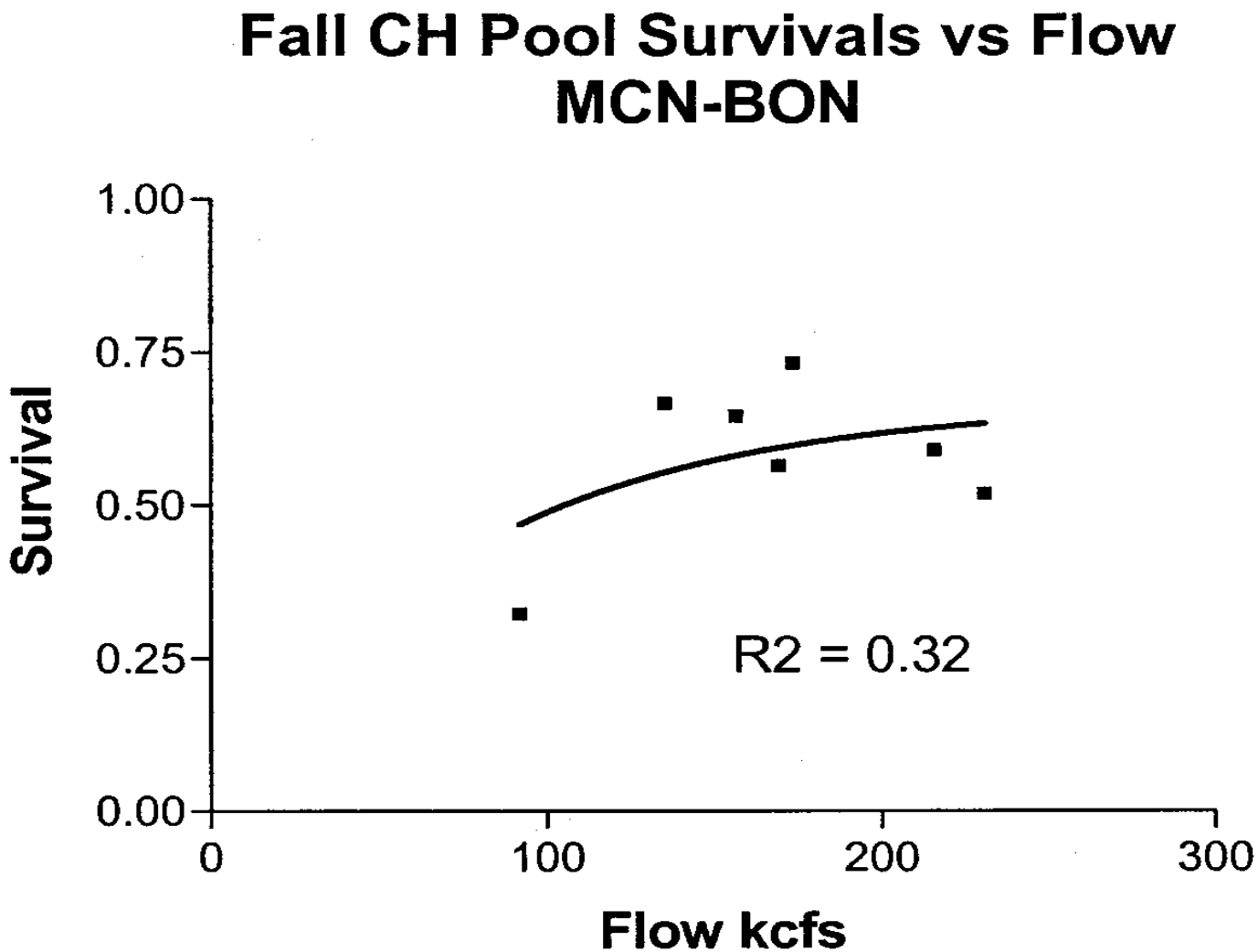
Development & Use of Flow-Survival Relationships (3)

- Step 2: Determine if a flow-survival relationship exists and, if so, define a functional relationship
- A regression analysis was performed for both lower Snake & Columbia reach pool survivals on seasonal average flows to obtain best-fit flow-survival relationships
- Resulting best-fit curves are shown below for each reach

Snake River Fall Chinook Pool Survivals vs Flows LGR-IHR




Fall CH Pool Survivals vs Flow
MCN-BON
Survival
1.00
0.75
0.50
0.25
0.00
0
100
200
300
Flow kcfs
R2 = 0.32

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Development & Use of Flow-Survival Relationships (4)

- Final Step: Apply each reach's flow-survival relationship to any flow changes derived from hydrosystem modeling of the P.A. or R.O.
- That is, changes in flow result in changes in pool survival based on best-fit relationship
- Pool survival improvement factors are calculated and applied to retrospective pool survivals in the model for each pool based on changes in average summer flow in P.A. or R.O.

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Survival Gap Analysis for SR Fall Chinook

- These pool survivals, together with changes in dam survival based on expected system configuration changes associated with P.A., allow SIMPAS to determine the relative difference in survival between two operations
- Relative (hydro) survival gap in draft 2004 BiOp between the 2004 & 2010 P.A. and the R.O. ranges from -13% to -5%