

Lake Ozette Sockeye Life Cycle Model

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Limiting Factors Analysis

Lake Ozette Sockeye Limiting Factors Analysis

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Prepared by:

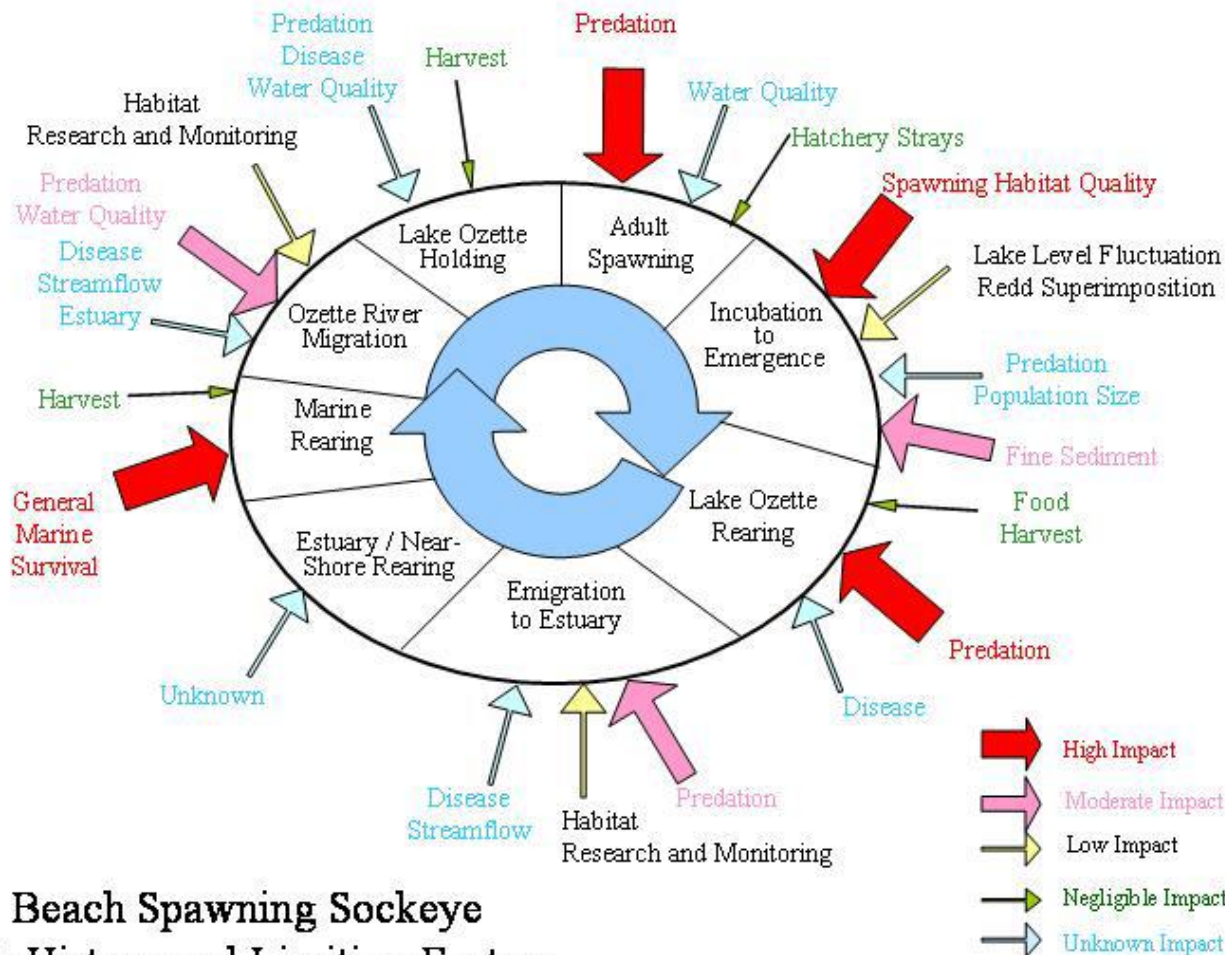
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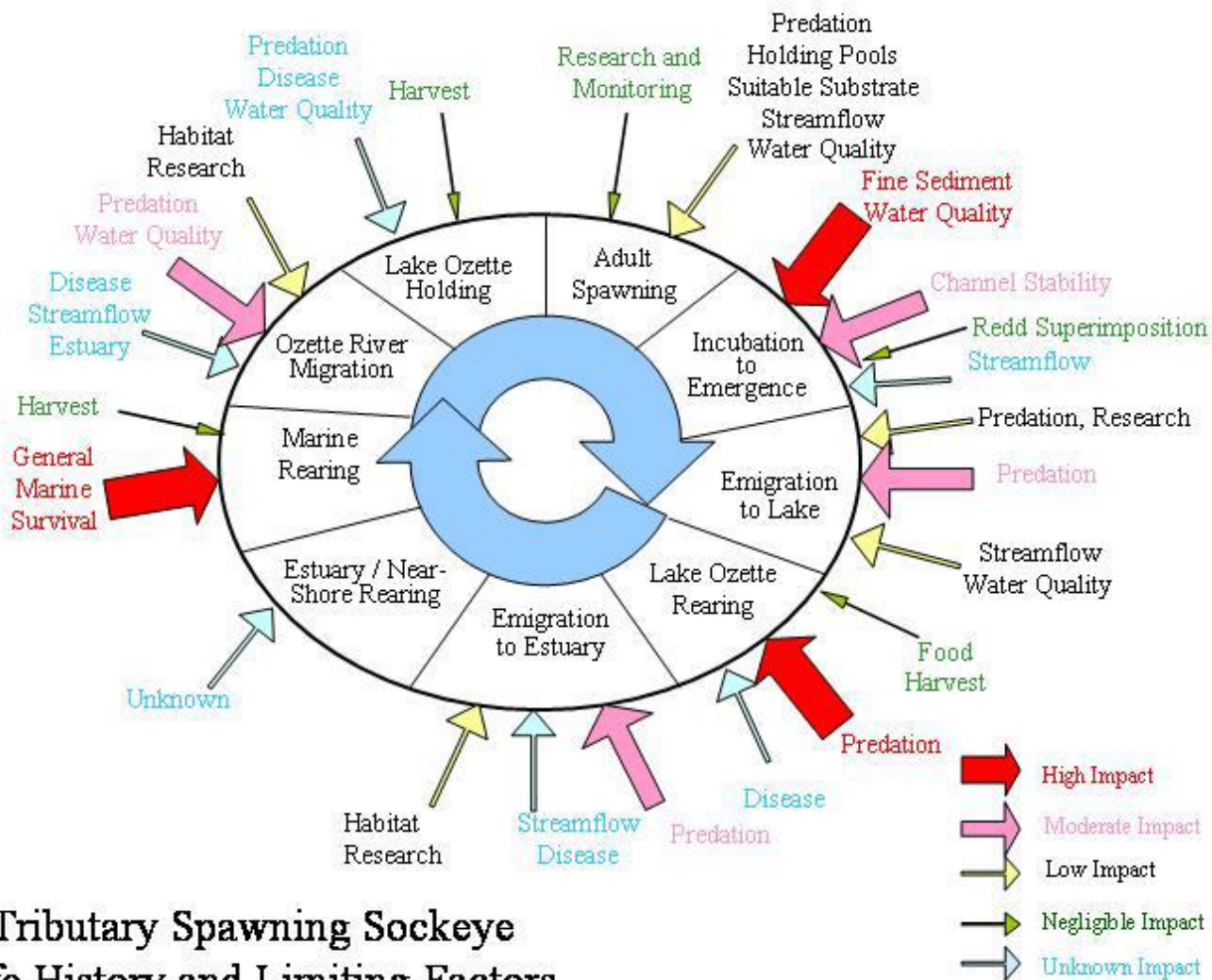
**Prepared for:
The Makah Indian Tribe and NOAA Fisheries, in Cooperation With the Lake
Ozette Sockeye Steering Committee**

Existing Sockeye Model



Beach Spawning Sockeye
Life History and Limiting Factors

Existing Sockeye Model



Tributary Spawning Sockeye
Life History and Limiting Factors

Existing Sockeye Model



surv_model_CC_8 [Compatibility Mode] - Excel

Woodward, Andrea

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AJ	
	Start A	Sockeye	Output	Survival	Mortality	Predation	EVENT	EVENT	su	LF	Rating	Abundance	Predation	Mortality	Event	Other Mortality	Plot Values	Predation Only	60%	20%	20%											
2	Start A	4,000	3,480	0.87	0.13	0.07	5	0.06	WQ	Moderate	0	15.0%			1	0.01	0	15.0%	16.0%	18.0%	21.0%											
3	Start B	4,000	3,480	0.87	0.13	0.07	5	0.06	Predation	Moderate	1,000	12.0%			2	0.01	1,000	12.0%	13.0%	15.0%	18.0%											
4	Start C	4,000	3,680	0.92	0.08	0.07	2	0.01	Habitat	Qua Low	2,000	9.0%			3	0.01	2,000	9.0%	10.0%	12.0%	15.0%											
5	Start D	4,000	3,680	0.92	0.08	0.07	1	0.01	Streamflow	Unknown	3,000	8.0%			4	0.03	3,000	8.0%	9.0%	11.0%	14.0%											
6	Return A1	793	650	0.82	0.18	0.15	4	0.03	Estuary	Unknown	4,000	7.0%			5	0.06	4,000	7.0%	8.0%	10.0%	13.0%											
7	Return B1	3,421	2,942	0.86	0.14	0.08	5	0.06	R&M	Low	5,000	5.8%					5,000	5.8%	6.8%	8.8%	11.8%											
8	Return C1	7,337	6,963	0.949	0.051	0.041	3	0.01			6,000	4.8%					6,000	4.8%	5.8%	7.8%	10.8%											
9	Return D1	6,867	6,468	0.942	0.058	0.048	2	0.01			7,000	4.1%					7,000	4.1%	5.1%	7.1%	10.1%											
10	Return A2	429	360	0.84	0.16	0.15	1	0.01			8,000	3.6%					8,000	3.6%	4.6%	6.6%	9.6%											
11	Return B2	6,106	5,752	0.942	0.058	0.048	2	0.01			9,000	3.2%					9,000	3.2%	4.2%	6.2%	9.2%											
12	Return C2	6,234	5,873	0.942	0.058	0.048	3	0.01			10,000	3.0%					10,000	3.0%	4.0%	6.0%	9.0%											
13	Return D2	7,319	6,580	0.899	0.101	0.041	5	0.06			20,000	1.6%					20,000	1.6%	2.6%	4.6%	7.6%											
14	Return A3	521	411	0.79	0.21	0.15	5	0.06			40,000	0.9%					40,000	0.9%	1.9%	3.9%	6.9%											
15	Return B3	6,015	5,366	0.892	0.108	0.048	5	0.06			80,000	0.5%					80,000	0.5%	1.5%	3.5%	6.5%											
16	Return C3	4,611	4,242	0.92	0.08	0.07	3	0.01																								
17	Return D3	9,389	8,995	0.958	0.042	0.032	1	0.01																								
18	Return A4	244	200	0.82	0.18	0.15	4	0.03																								
19	Return B4	3,204	2,851	0.89	0.11	0.08	4	0.03																								
20	Return C4	6,721	6,332	0.942	0.058	0.048	3	0.01																								
21	Return D4	10,885	10,450	0.96	0.04	0.03	1	0.01																								
22	Return A5	379	318	0.84	0.16	0.15	1	0.01																								
23	Return B5	6,005	5,657	0.942	0.058	0.048	3	0.01																								
24	Return C5	8,420	8,032	0.954	0.046	0.036	2	0.01																								
25	Return D5	17,599	16,895	0.96	0.04	0.03	1	0.01																								
26	Return A6	723	593	0.82	0.18	0.15	4	0.03																								
27	Return B6	8,109	7,736	0.954	0.046	0.036	1	0.01																								
28	Return C6	11,039	10,597	0.96	0.04	0.03	3	0.01																								
29	Return D6	23,314	24,656	0.974	0.026	0.016	2	0.01																								
30	Return A7	1,257	1,068	0.85	0.15	0.12	4	0.03																								
31	Return B7	10,253	9,330	0.91	0.09	0.03	5	0.06																								
32	Return C7	3,811	3,278	0.86	0.14	0.08	5	0.06																								
33	Return D7	14,445	13,868	0.96	0.04	0.03	1	0.01																								
34	Return A8	1,680	1,462	0.87	0.13	0.12	3	0.01																								
35	Return B8	2,015	1,774	0.88	0.12	0.09	4	0.03																								
36	Return C8	4,902	4,265	0.87	0.13	0.07	5	0.06																								
37	Return D8	18,106	17,382	0.96	0.04	0.03	3	0.01																								
38	Return A9	3,716	3,382	0.91	0.09	0.08	2	0.01																								
39	Return B9	1,782	1,550	0.87	0.13	0.12	1	0.01																								
40	Return C9	6,542	6,032	0.922	0.078	0.048	4	0.03																								
41	Return D9	12,866	12,094	0.94	0.06	0.03	4	0.03																								
42	Return A10	6,025	5,555	0.922	0.078	0.048	4	0.03																								
43	Return B10	1,361	1,184	0.87	0.13	0.12	3	0.01																								
44	Return C10	4,176	3,633	0.87	0.13	0.07	5	0.06																								
45	Return D10	16,152	15,183	0.94	0.06	0.03	4	0.03																								
46	Return A11	11,641	10,594	0.91	0.09	0.03	5	0.06																								

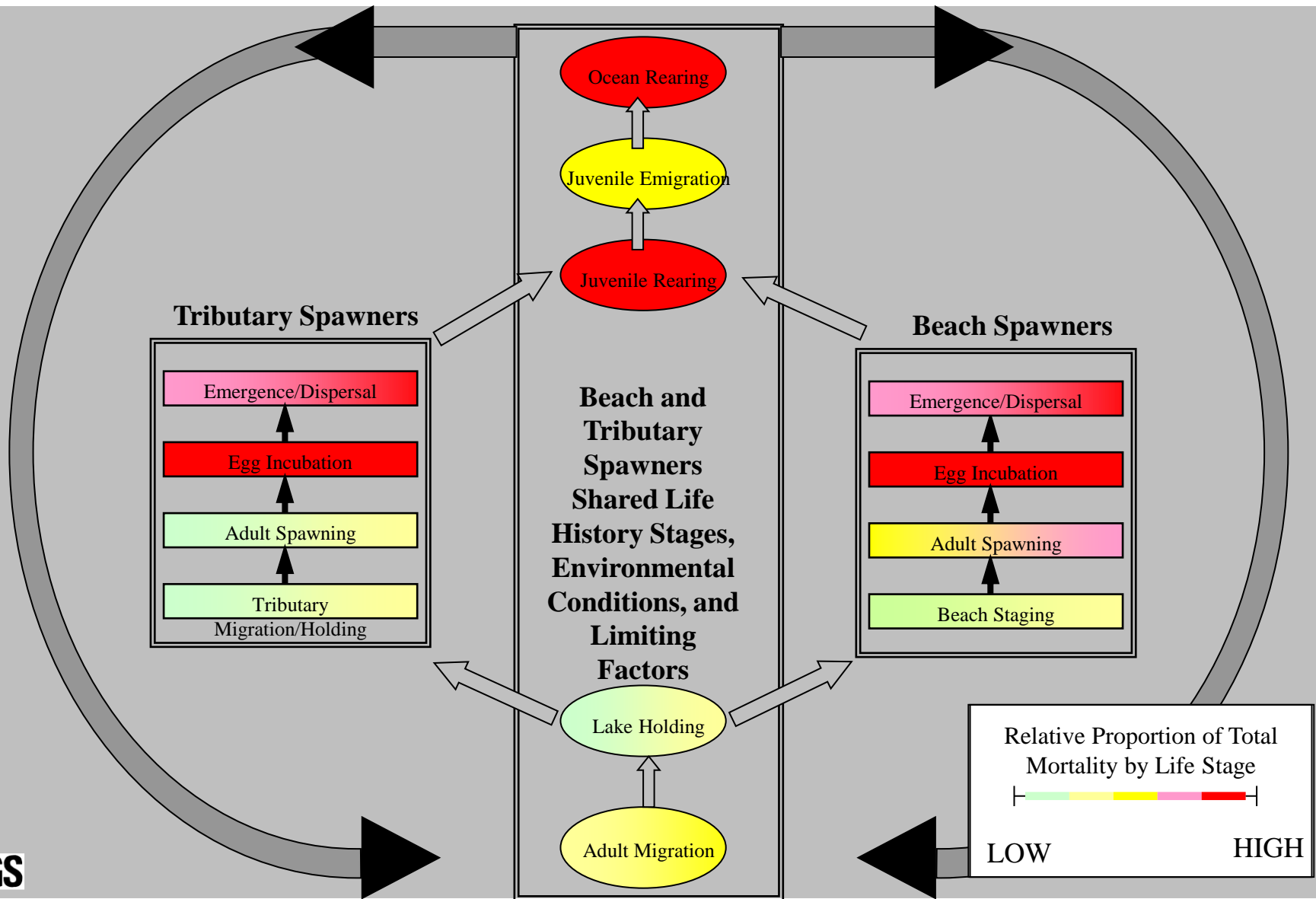
READY



Benefits of System Dynamics Model

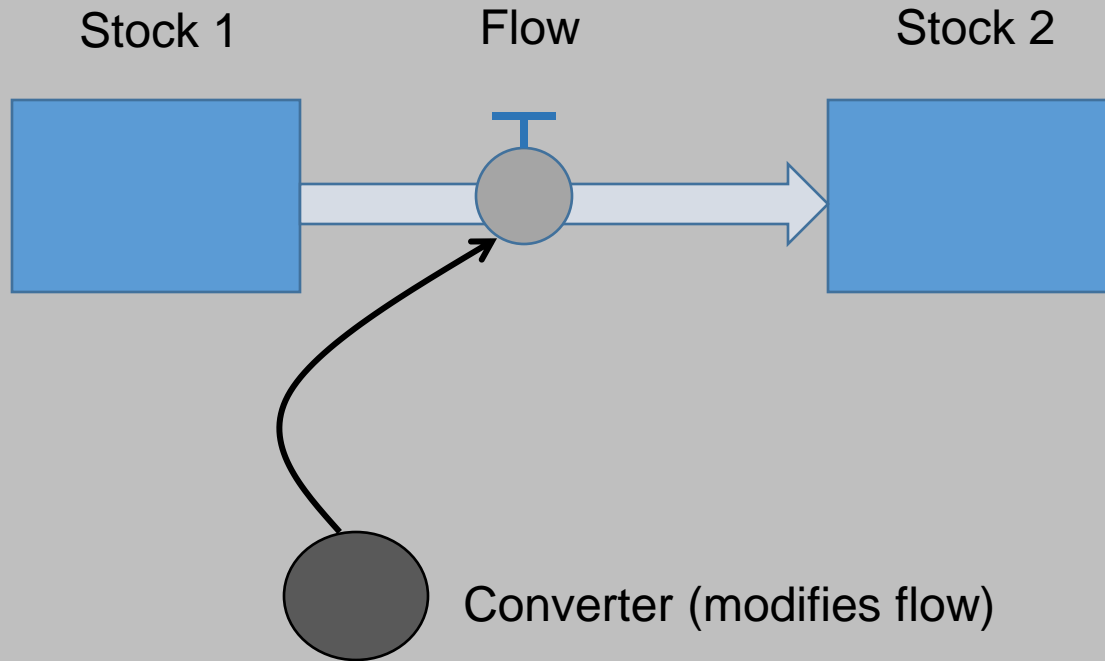
- User-friendly modeling environment
- Create a framework for incorporating new information
- Identify information gaps
- Evaluate consequences of potential actions
- Build consensus around a problem

Lake Ozette Sockeye Conceptual Model



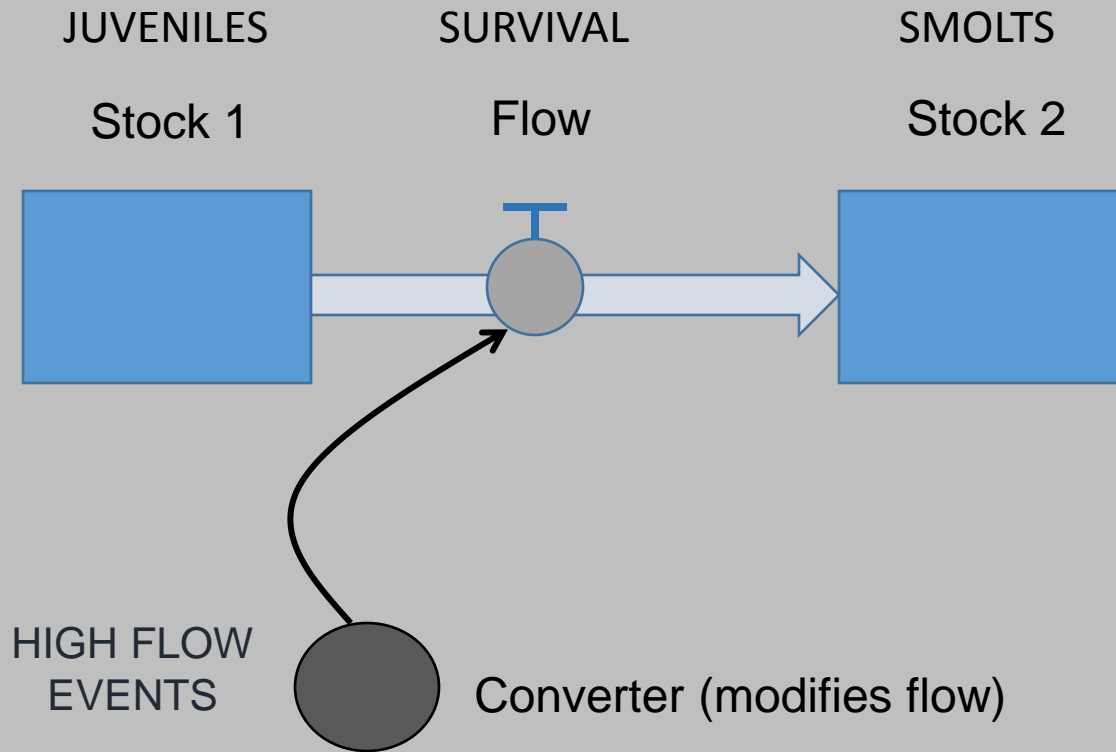


System Dynamics Model

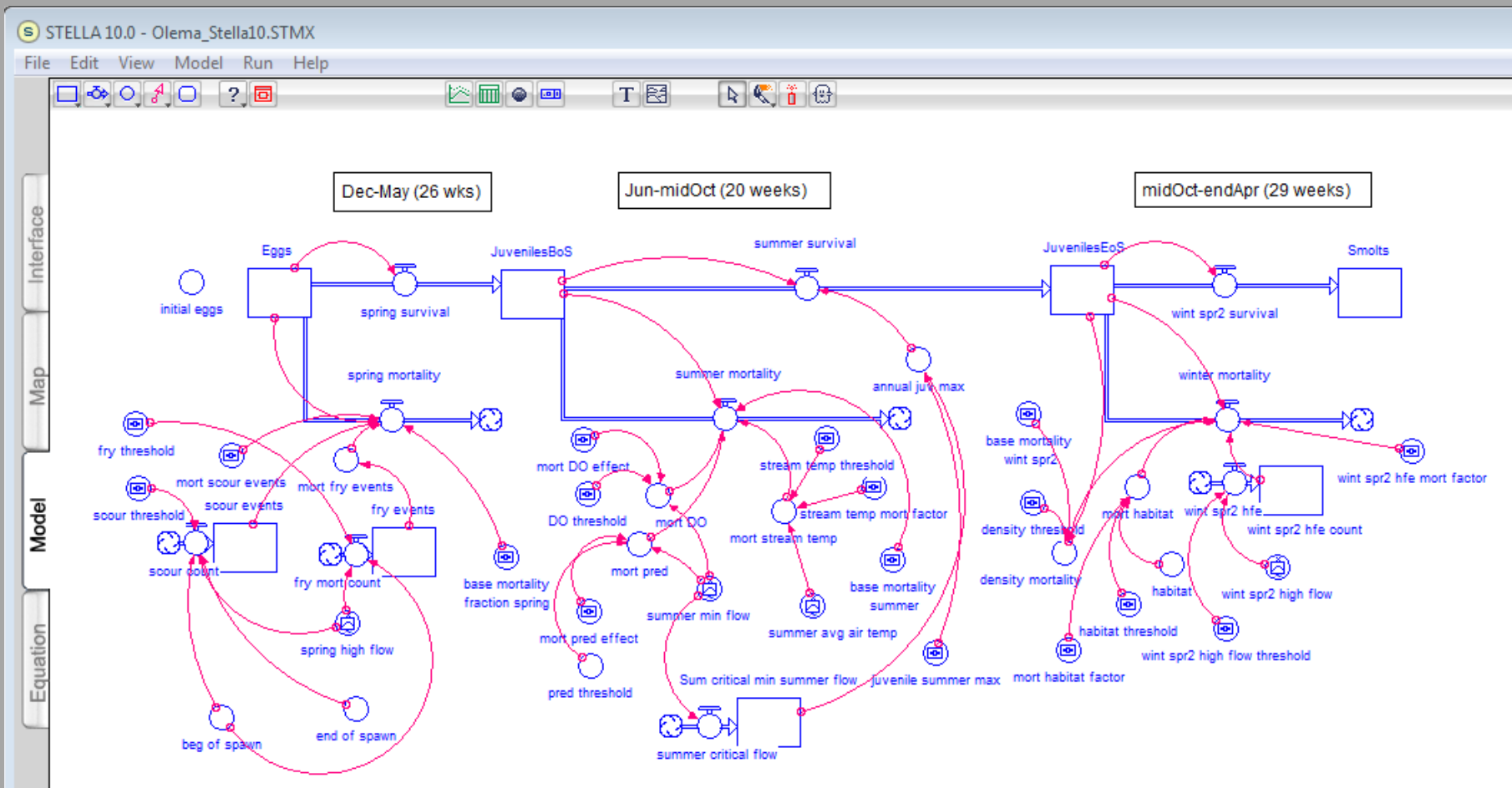




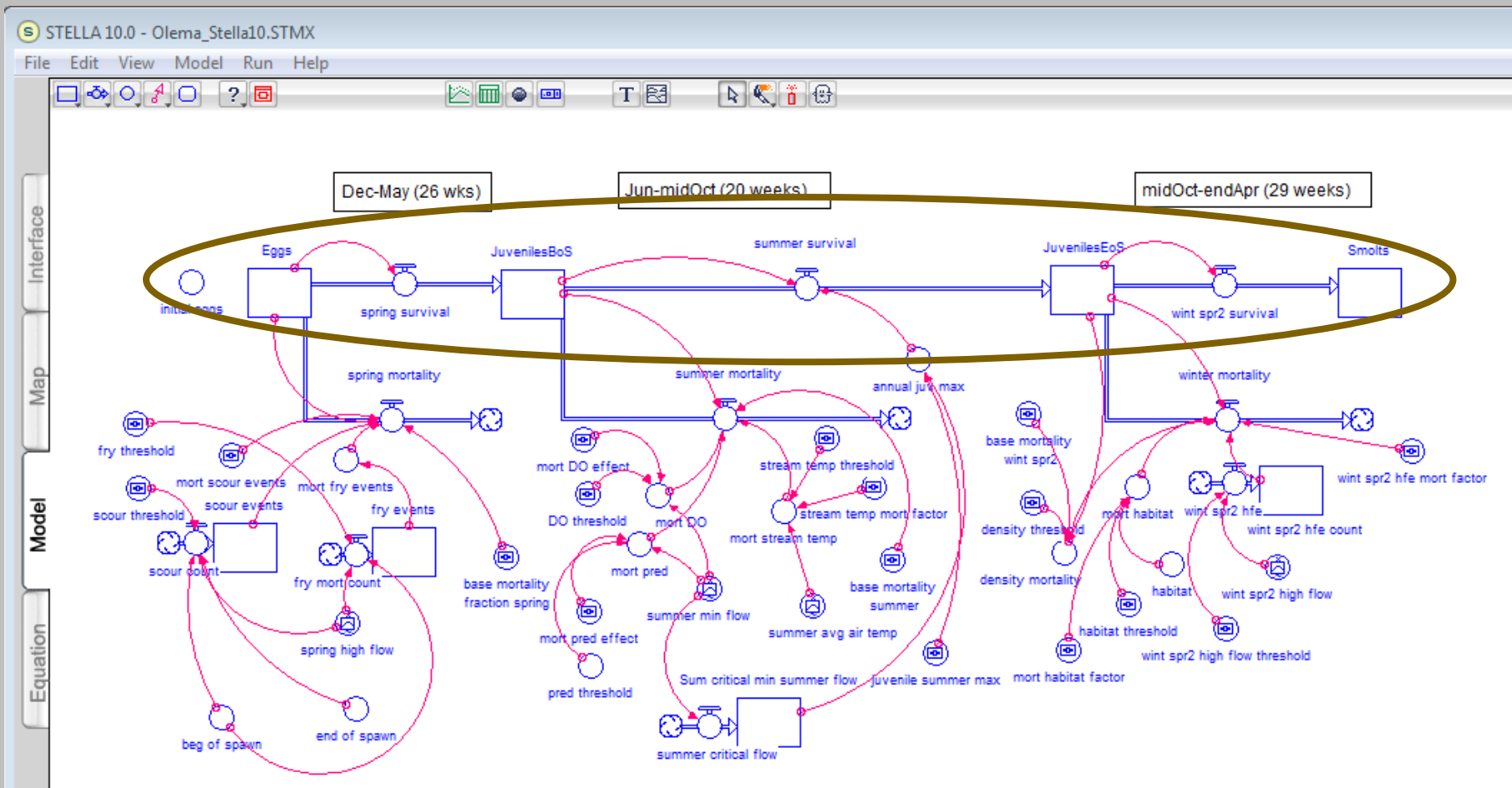
System Dynamics Model



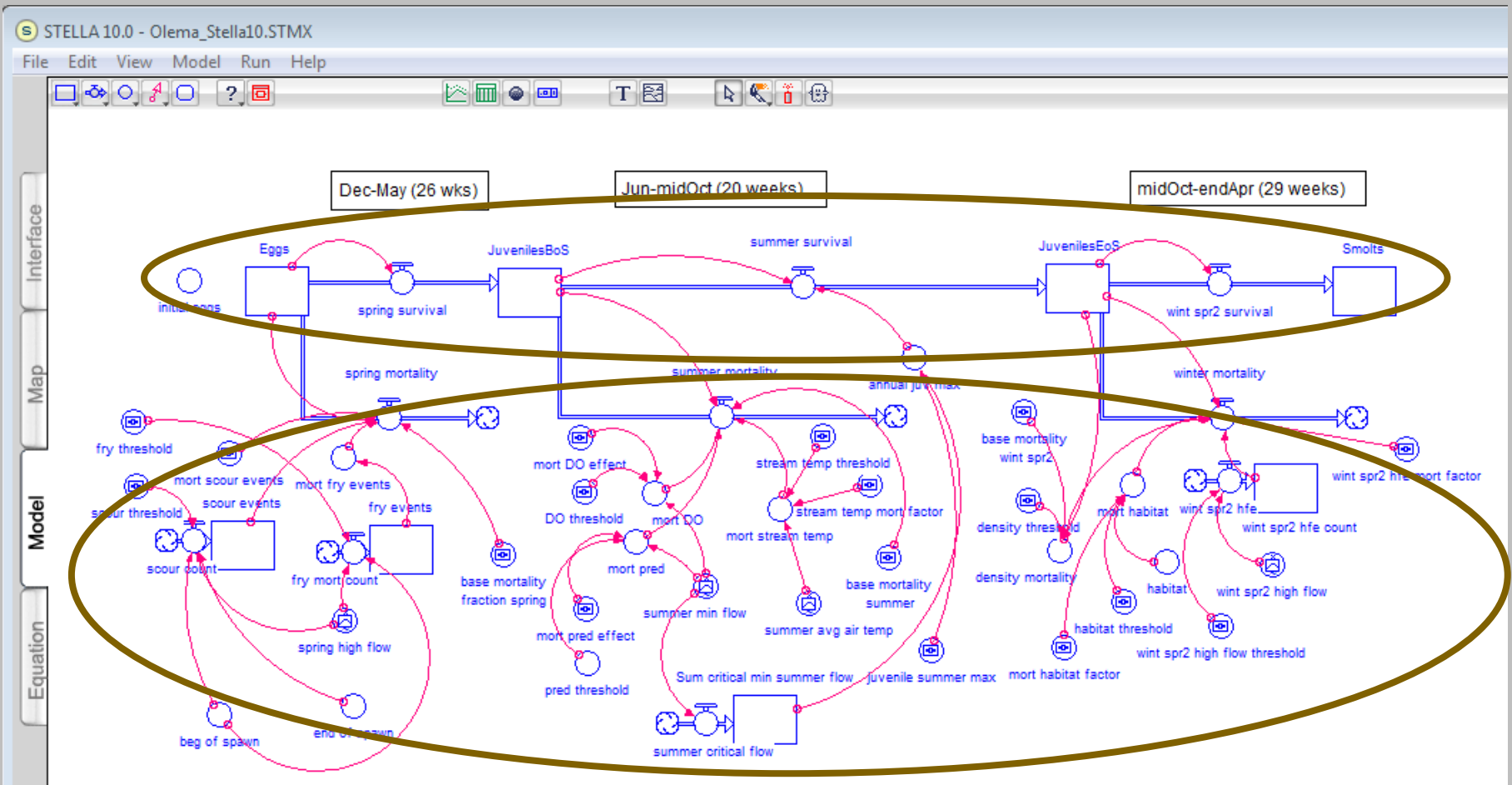
Stella® Simulation Model



Stella® Simulation Model



Stella® Simulation Model





User Interface

STELLA 10.0 - Olema_Stella10.STMX

File Edit View Interface Run Help

Interface Map Model Equation

Egg to Juvenile - 1 Dec to 30 May

base mortality fraction spring: 0.60000 to 0.90000 (0.77000)

scour threshold: 800.00 to 1500.00 (1090.00)

fry threshold: 150.000 to 400.000 (200.000)

mort scour events: 0.8000 to 1.0000 (0.9800)

spring high flow

Juveniles during Summer - 1 Jun to 18 Oct

base mortality summer: 0.00000 to 0.10000 (0.00700)

DO threshold: 3.5000 to 5.5000 (4.5000)

mort DO effect: 0.00000 to 0.90000 (0.01000)

mort pred effect: 0.00000 to 0.04000 (0.01000)

stream temp threshold: 17.0000 to 25.0000 (18.0000)

stream temp mort factor: 0.01000 to 0.20000 (0.01000)

juvenile summer max: 2000.0 to 10000.0 (5100.0)

summer min flow

summer avg air temp

Juvenile to Smolt - 19 Oct to 3 May

base mortality wint spr2: 0.00000 to 0.50000 (0.20000)

density threshold: 2000.0 to 30000.0 (20000.0)

wint spr2 high flow threshold: 200.000 to 500.000 (300.000)

habitat threshold: 200.000 to 800.000 (400.000)

mort habitat factor: 0.00000 to 0.30000 (0.00000)

wint spr2 hfe mort factor: 0.00000 to 0.80000 (0.00000)

wint spr2 high flow



User Interface

The screenshot displays the STELLA 10.0 software interface for the model 'Olema_Stella10.STMX'. The interface is organized into several panels:

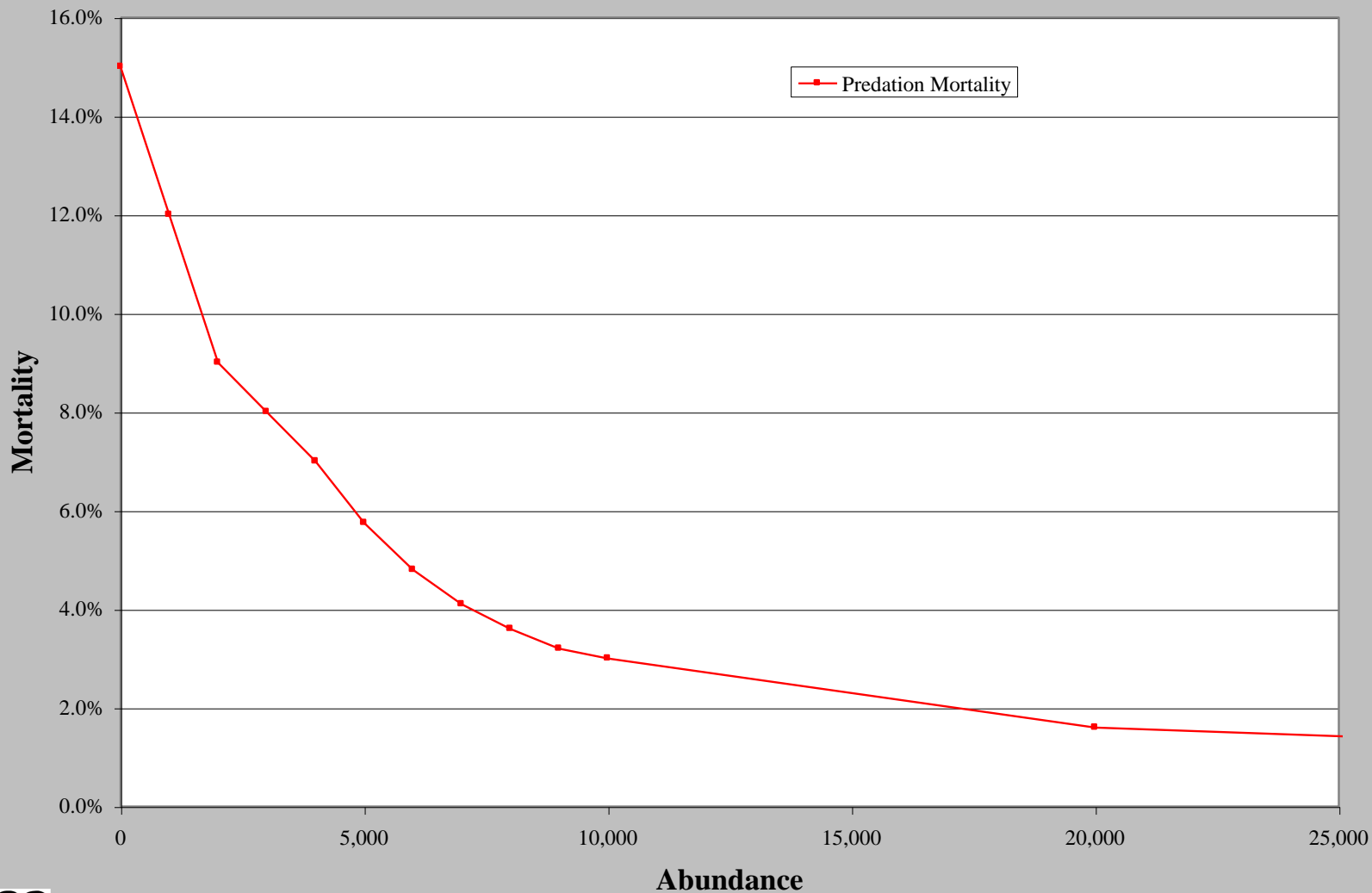
- Interface Panel:** Contains sliders for 'base mortality fraction spring' (0.60000 to 0.90000, value 0.77000), 'scour threshold' (800.00 to 1500.00, value 1090.00), 'fry threshold' (150.000 to 400.000, value 200.000), and 'mort scour events' (0.8000 to 1.0000, value 0.9800).
- Map Panel:** Shows a small graph titled 'spring high flow'.
- Model Panel:** Contains sliders for 'mortality DO effect' (0.00000 to 0.90000, value 0.01000), 'mortality pred effect' (0.00000 to 0.04000, value 0.01000), 'stream temp threshold' (17.0000 to 25.0000, value 18.0000), 'stream temp mortality factor' (0.01000 to 0.20000, value 0.01000), and 'juvenile summer max' (2000.0 to 10000.0, value 5100.0).
- Equation Panel:** Contains sliders for 'density threshold' (2000.0 to 30000.0, value 20000.0), 'winter spr2 high flow threshold' (200.000 to 500.000, value 300.000), 'habitat threshold' (200.000 to 800.000, value 400.000), 'mortality habitat factor' (0.00000 to 0.30000, value 0.00000), and 'winter spr2 hfe mortality factor' (0.00000 to 0.80000, value 0.00000).

A large, semi-transparent box is overlaid on the 'scour threshold' slider, showing a zoomed-in view of the slider with the value 1090.00 displayed in a digital font. The text 'scour threshold' is written above the slider in a stylized, multi-colored font.



Predation during Adult Migration

Adult Migration Mortality





Uses for the Model

- Simulating a conceptual model
- Articulating hypotheses
- Framework for incorporating new hypotheses
- Identify data gaps and critical information needs
- Motivate research
- Experiment with environmental and management scenarios

Thanks!



Photos: NPS