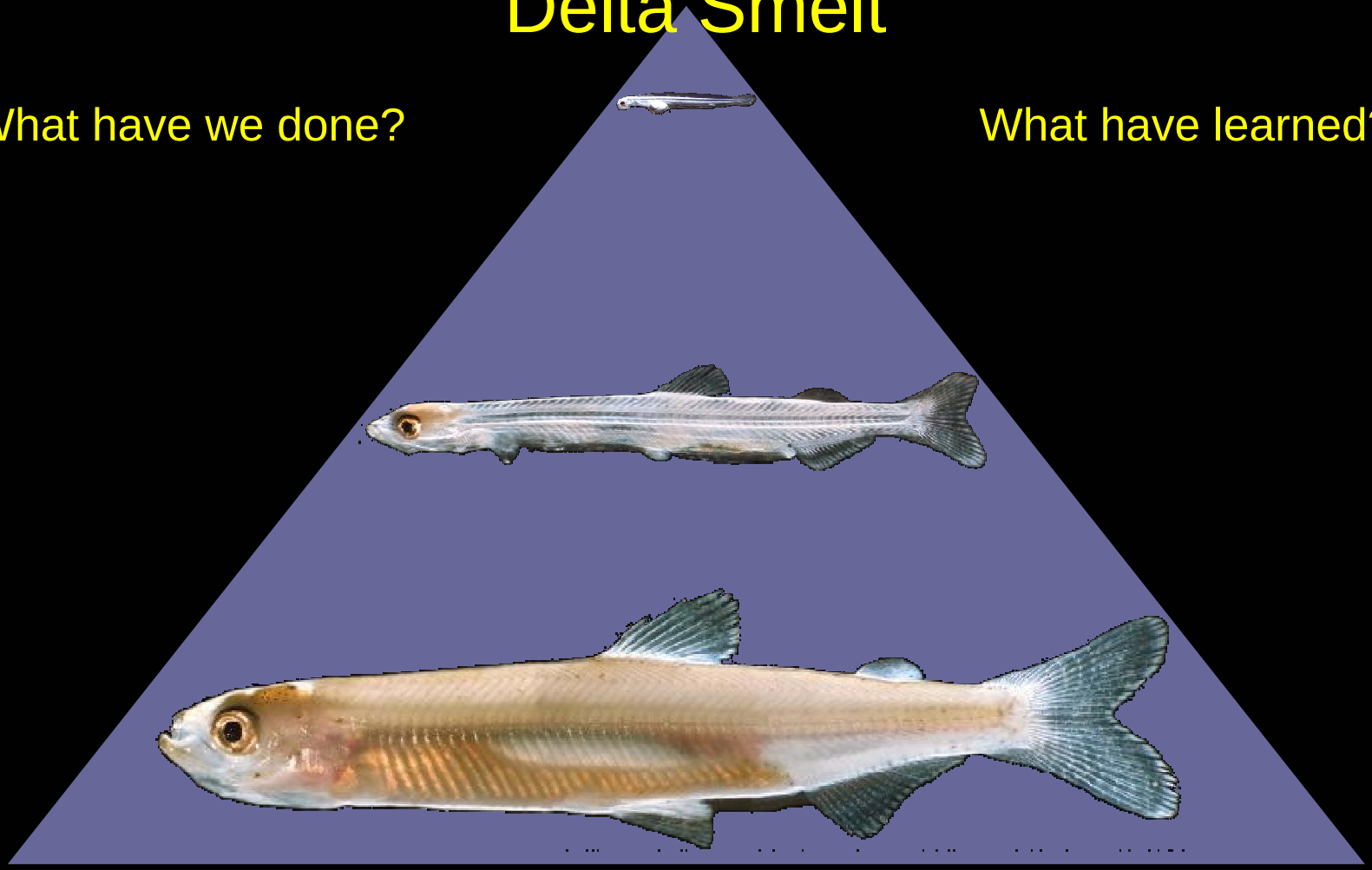
EWA
&
Delta Smelt

What have we done?

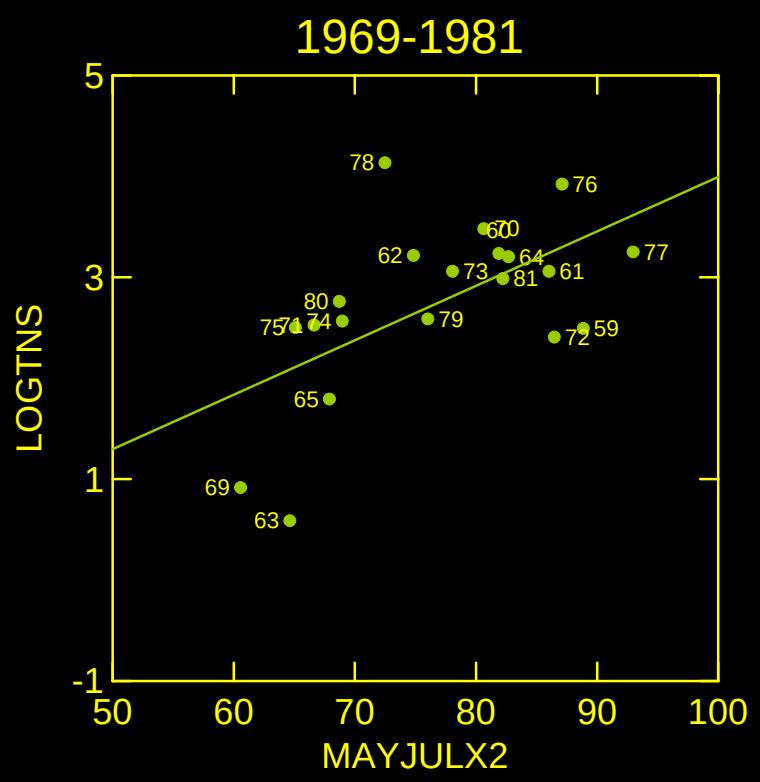
What have learned?

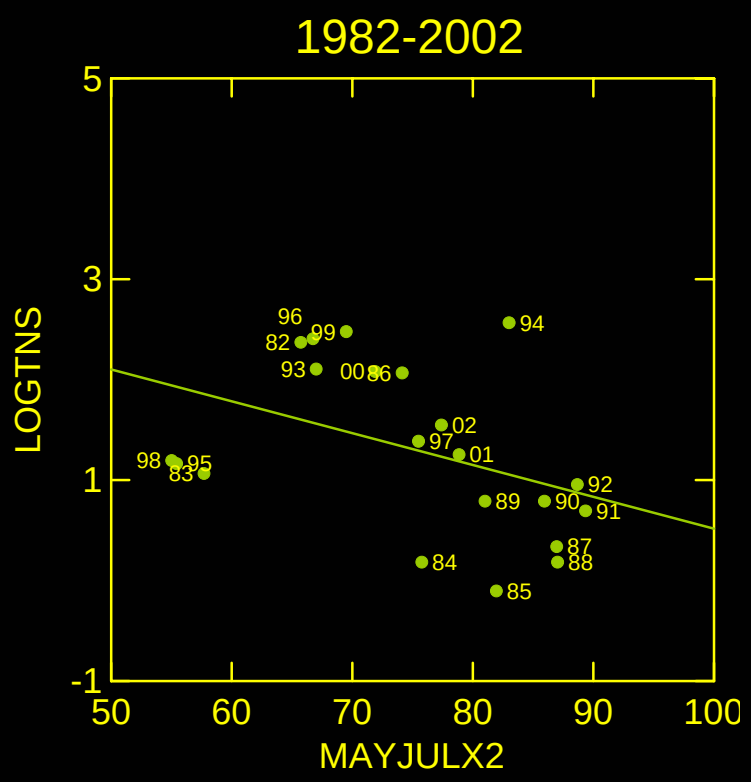


What should we do next?

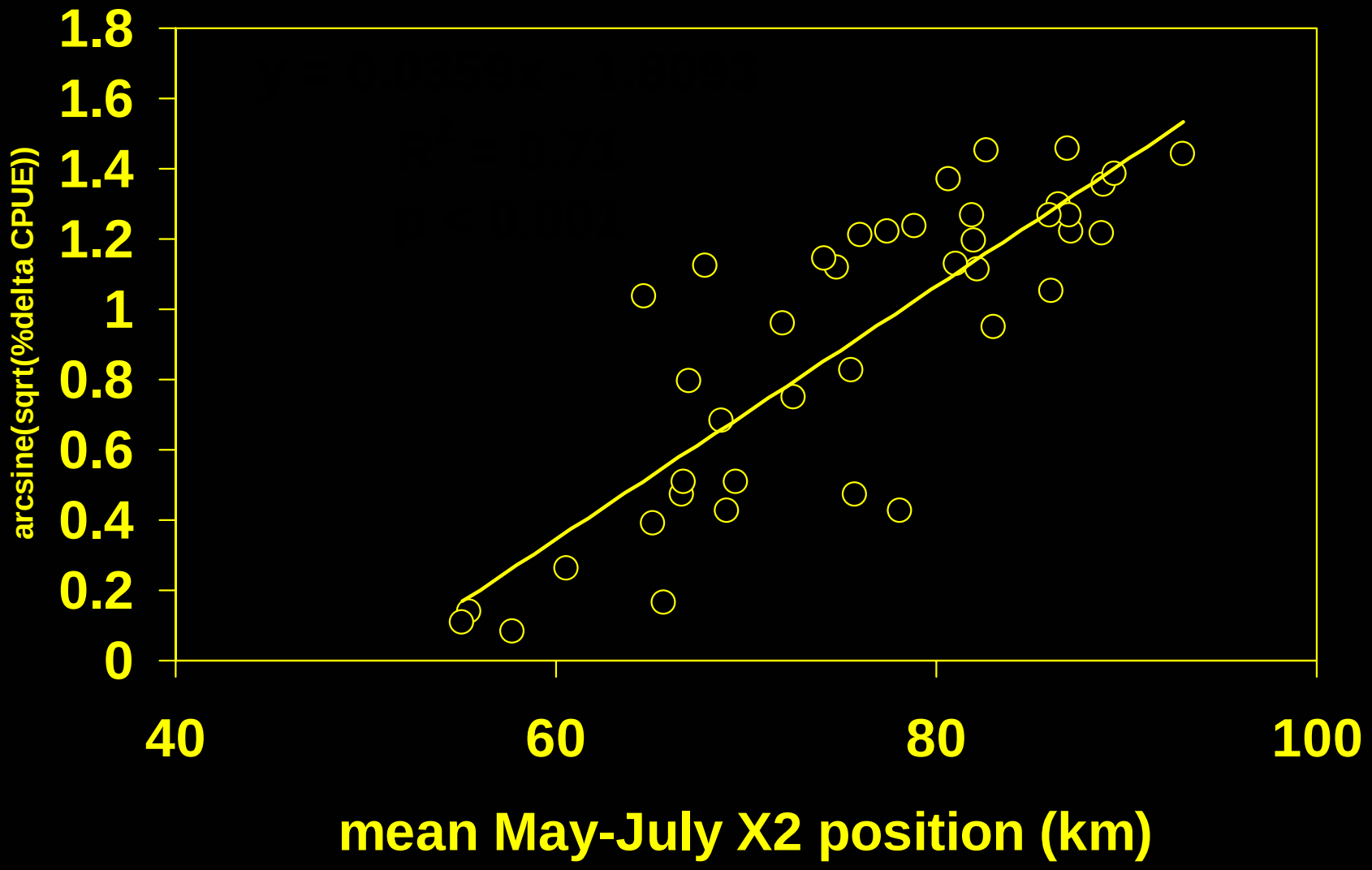
Kevin Fleming
California Department of Fish and Game

Delta Smelt Abundance and X2

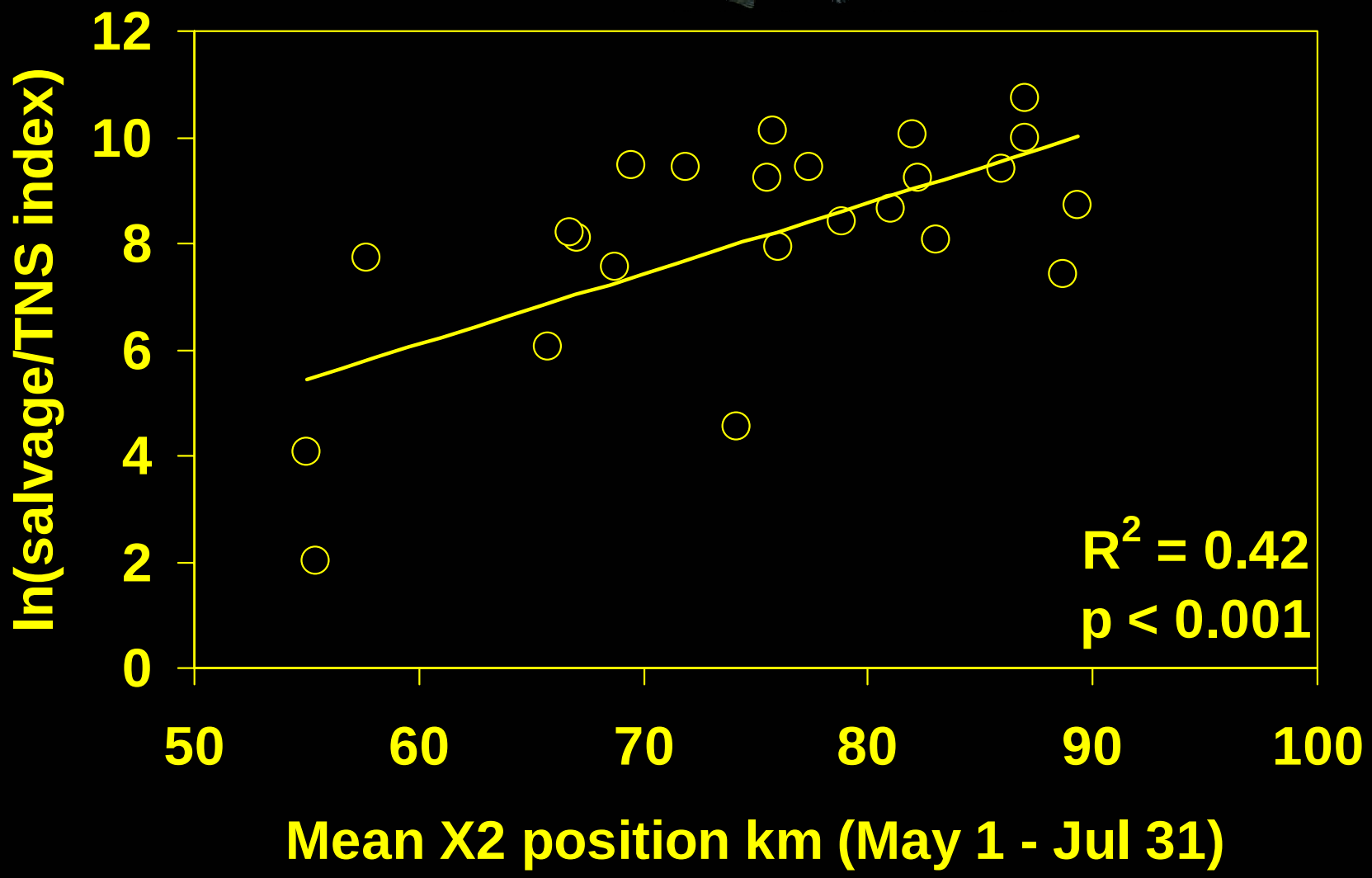




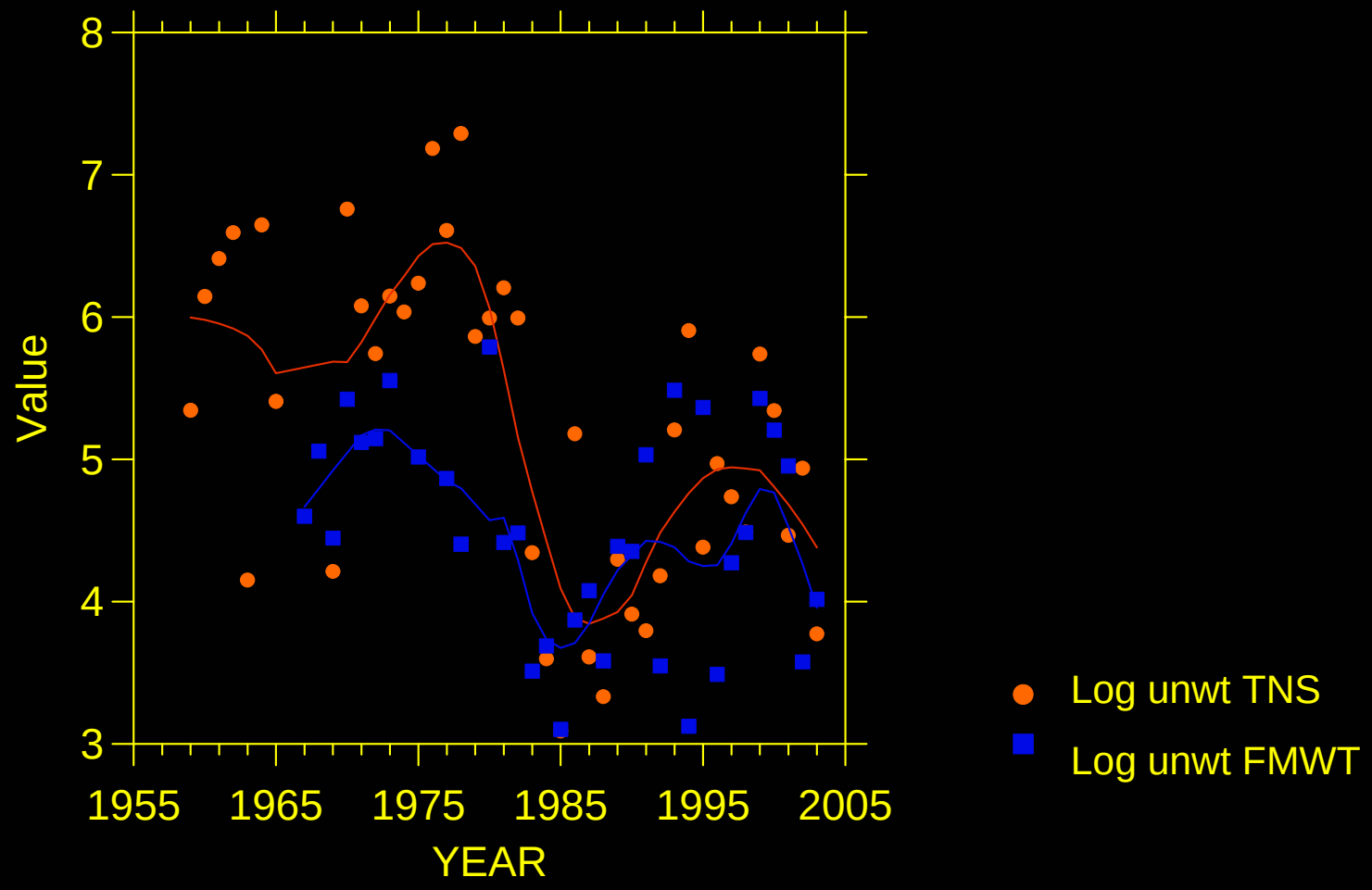
Delta smelt distribution is a function of flow



Delta smelt loss is a function of flow



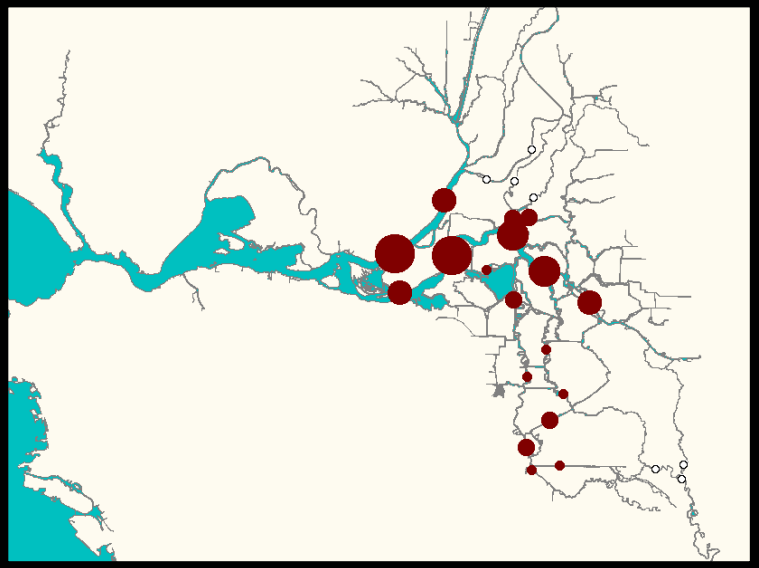
Abundance trends similar between Juv and Adult



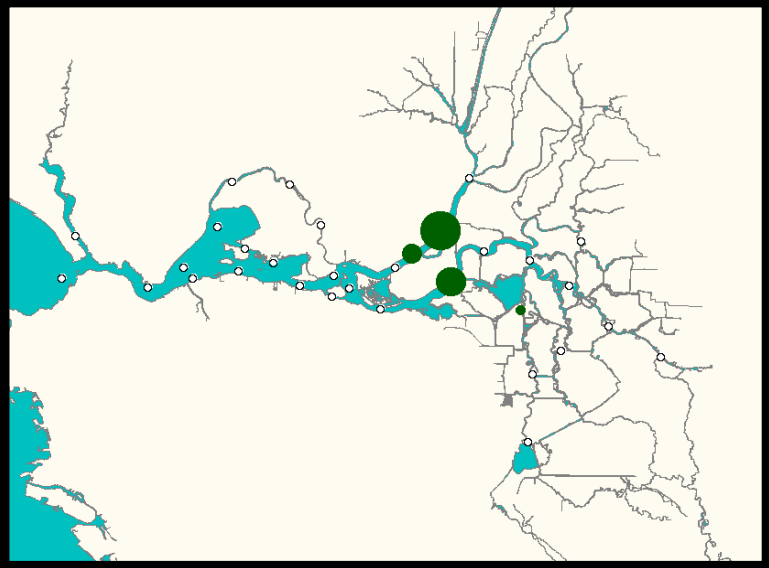
Abundance decline greatest in the lower delta

Year	323	328	329	336	340	405	411	418	501	504	508	513	519	520	602	606	609	610	704	706	707	801	804	809	812	815	902	906	910	912	914	915	918	919
1959												18		1					224		105		1	27	7	5		1	4					
1960						10				2		37	11	4	5	4	7	4	599		46		4	28	11	46	3	42	26		5	3		
1961						2				2		9	4	3	33	47	139	61	235		147		21	28	80	16	22	25	31	1	42	59	18	11
1962									12	20	40	48	49	9	36	16	22	26	251	581	88	4		87	26	14		5	9	4	7	1	1	16
1963								1	1		5		2	2	8	1	9	4	2	3	1	3	9	5	1	19	1	23	14		7	1		4
1964						2				2	4	4		4	2			3	274	301	409	10	2	6	134	41	66	71	30	2	56	51	23	10
1965									3		5	11	2	3	3	2	34	21	27	8	9	8	29	7	6	57	14	116	18	1	30	14	12	4
1969						5	6	1	18	3	5	4	5		57	3	14	5	2				1		1	1								2
1970									3	6	19	12	3	11	2			12	596	403	440	3	12	21	40	6	4	8	32	21	28	2	2	8
1971							48		82	27	57	44	118	16	118	11	86	86	3	1		21	11	8	15	16	14	30	18	2	17	5	7	12
1972									5	7	11	6	2	1	1	5	7	1	61	177	120	1	4	44	29	113	4	4	2	6	5		8	
1973							31		281	25	47	122	10	3	248		2	5				27	35	95					2		1	1		
1974						1	19		67	7	214	78	62	92	58	7	70	18	2		2	30	17	35	2	44	1	5		1	1		1	2
1975									5	4	36	242	107	100	36	23	198	123	9	3		50	11	9	27	12	2	4	14	2	2	2		2
1976							2		4	9	112	37	32	5	73	1	3	33	940	1076	99	28	39	89	20	16		1	9	6	4			1
1977										1	10	3	3	7	1				339	469	446	2	6	33	8	5	1	2	119	5			1	4
1978									1	2	95	92	32	43	1137	10	155	9	1061	266	1	3	4	12	1	1				1		1		3
1979							3		2	1	4	16	3	26	17		16		286	287	19	2	4	3				1	6	6			1	1
1980						2	2	1	28	79	45	139	13	42	24	29	75	2	186	25		50	6	38	8	2			2					3
1981						1	1		4	6	18	47	50	11	10		8	39	477	233	31	7	6	24	13	1	2					1		1
1982					38		25	2	39	72	31	24	102	216	139	22	56	13	1	3		10	8											
1983	5		20	5	22	4	28		3	1	2			1	63	3	21													1				
1984						2			3	3	6	11	9	5	13		3	3	7	3	2	1	1	1										
1985												4	1	1					18	14	2			1			1				2			
1986									2	2	8	26	2	8	7		4	2	215	65	2	1	1	3							7			
1987						1														12	30	1	8	15	1		2			1	2	1		
1988											1	3	1						21	9	10		2	5	3	1								
1989						1					1	6	2	3	3	3	8		14	95	4		3			3					1			
1990											1				5			3	52	26		1	5	5			1							1
1991																2	1		56	16	5			2	3	2		1	1					
1992											1	14		1					20	30	48		3	13								1		
1993						2	19		18	14	17	42	22	6	38		1		152	18	2		9	5										
1994						7			1		87	77	14	47	13		1	1	137	122	117	62	33	8		4			1				1	
1995		1		1	8	8	4	8	32	7	4	4	12	2	66		2		2			1												
1996				1	4	7	12	3	9	14		20	21	1	15	2	2		16	15	2	1												
1997						7				1	44	27	10	3	13				47	64	6	4		2										
1998	4		9	13	25	36	3	27	12	11	4		4	1	30	8	9	2	1					1										
1999	2				1	38	9	10	27	6	65	81	50	7	170	6	3		75	42	15	9	2	2	1	1								
2000						2	2	1	2		34	45	5	11	20	4	6	5	140	87	35	12	2	3					1	1				
2001					2		1				3	2	7	1	1			2	77	49	11	2	7	5	3	1								
2002									1		17	9		1	5				46	156	33	3		7										
2003											9	13	5	6	2	4	3	3	28	1	3	7	2	1										

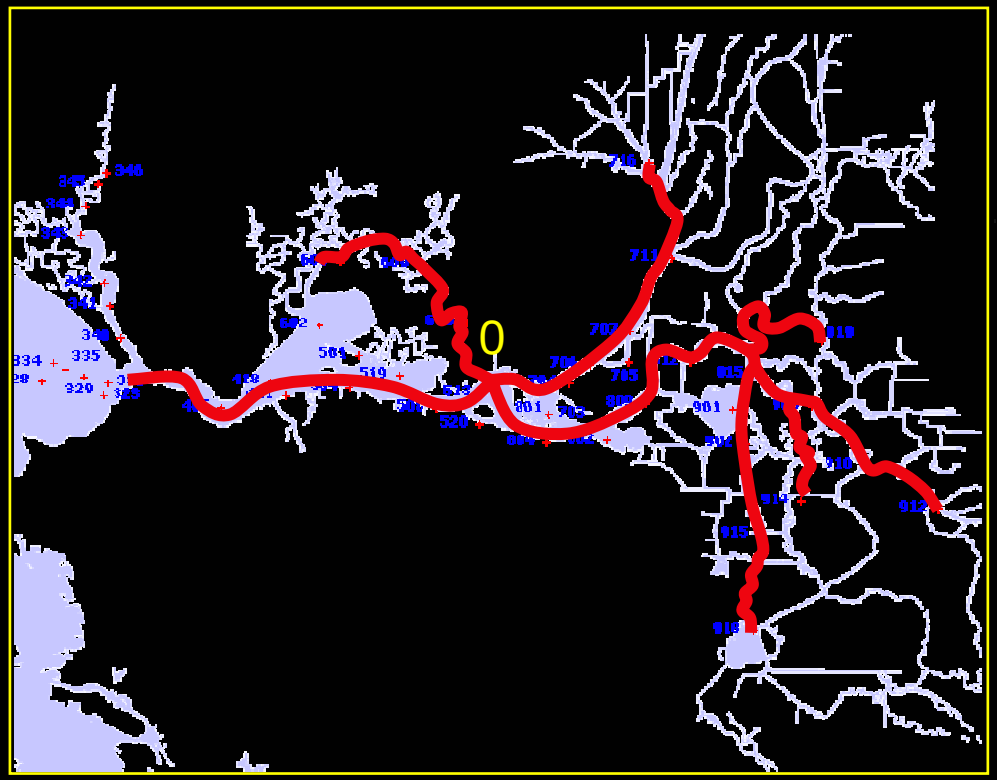
An in-delta distribution during the summer
Goes along way back



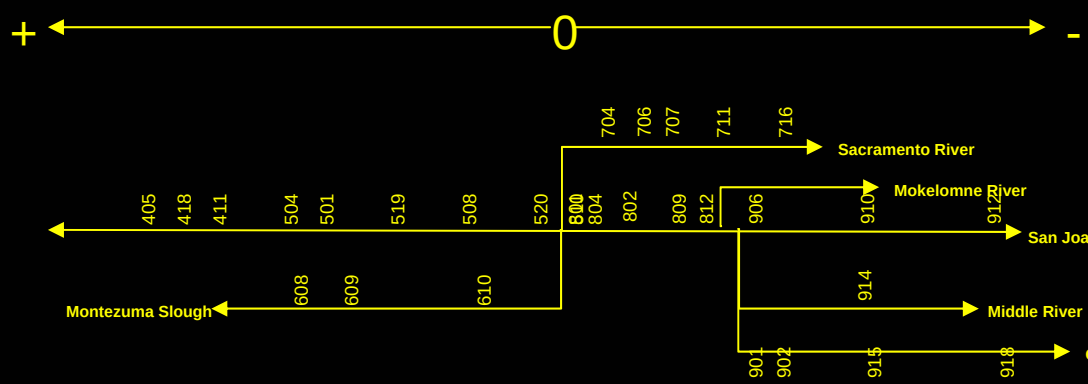
Mid-July, 1948



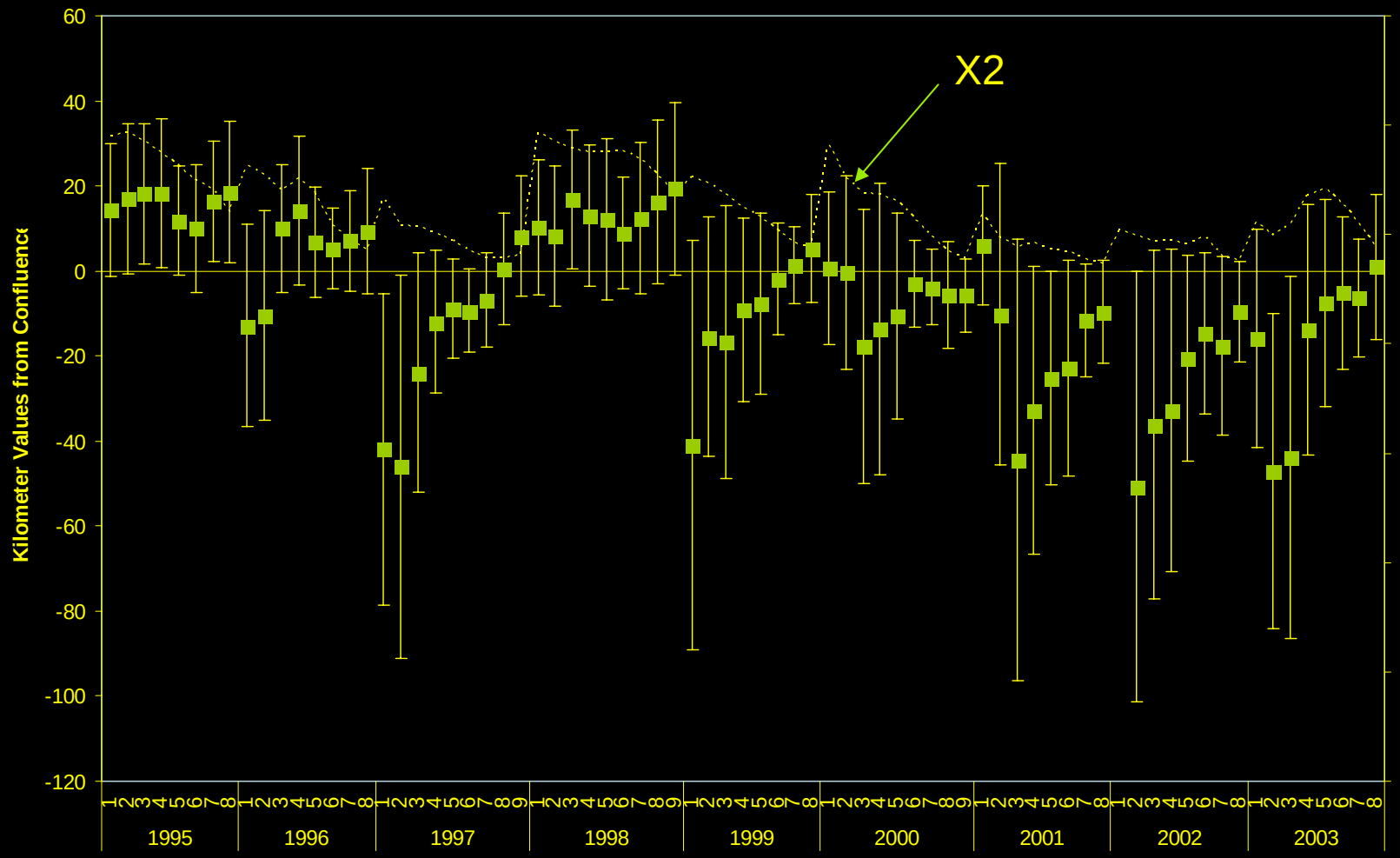
Early June, 1987



$$\text{Centroid} = \frac{\sum (Km \times CPUE)}{\sum CPUE}$$



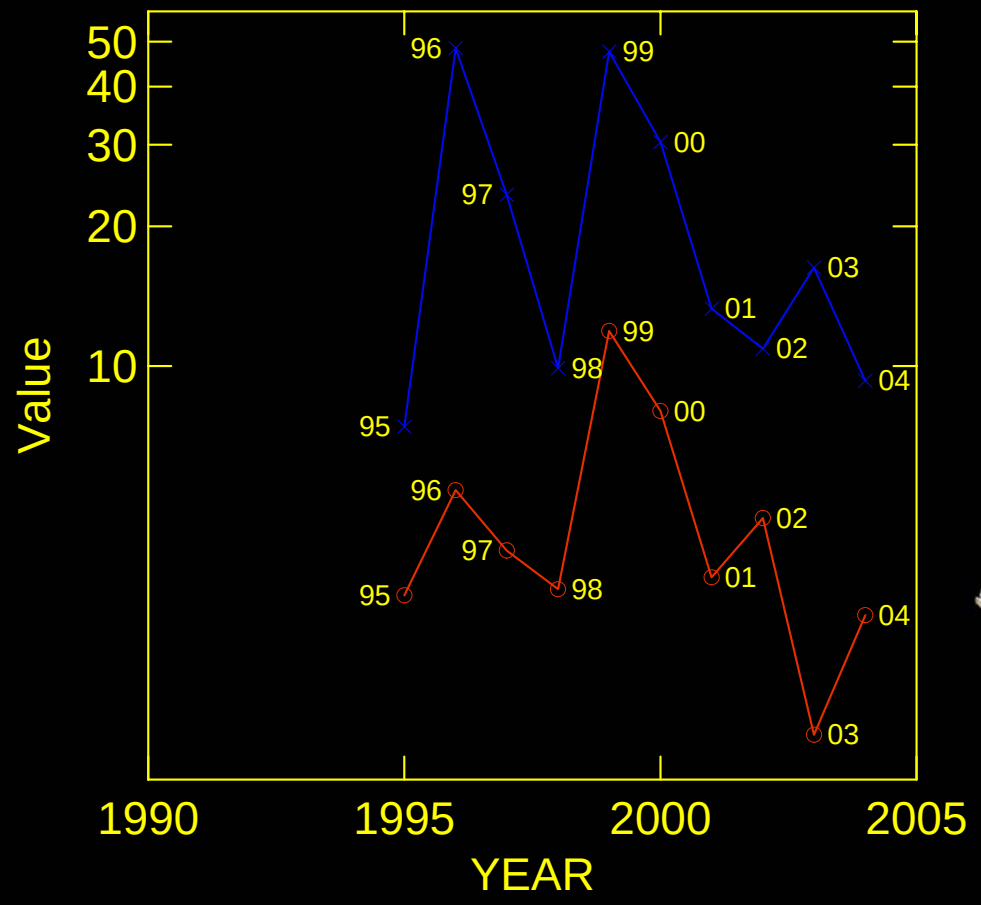
Delta smelt start in the delta



Abundance decline greatest in the lower delta

Year	323	328	329	336	340	405	411	418	501	504	508	513	519	520	602	606	609	610	704	706	707	801	804	809	812	815	902	906	910	912	914	915	918	919
1959												18		1					224		105		1	27	7	5		1	4					
1960						10				2		37	11	4	5	4	7	4	599		46		4	28	11	46	3	42	26		5	3		
1961						2				2		9	4	3	33	47	139	61	235		147		21	28	80	16	22	25	31	1	42	59	18	11
1962									12	20	40	48	49	9	36	16	22	26	251	581	88	4		87	26	14		5	9	4	7	1	1	16
1963								1	1		5		2	2	8	1	9	4	2	3	1	3	9	5	1	19	1	23	14		7	1		4
1964						2				2	4	4		4	2			3	274	301	409	10	2	6	134	41	66	71	30	2	56	51	23	10
1965									3		5	11	2	3	3	2	34	21	27	8	9	8	29	7	6	57	14	116	18	1	30	14	12	4
1969						5	6	1	18	3	5	4	5		57	3	14	5	2				1		1	1								2
1970									3	6	19	12	3	11	2			12	596	403	440	3	12	21	40	6	4	8	32	21	28	2	2	8
1971							48		82	27	57	44	118	16	118	11	86	86	3	1		21	11	8	15	16	14	30	18	2	17	5	7	12
1972									5	7	11	6	2	1	1	5	7	1	61	177	120	1	4	44	29	113	4	4	2	6	5		8	
1973							31		281	25	47	122	10	3	248		2	5				27	35	95					2		1	1		
1974						1	19		67	7	214	78	62	92	58	7	70	18	2		2	30	17	35	2	44	1	5		1	1		1	2
1975									5	4	36	242	107	100	36	23	198	123	9	3		50	11	9	27	12	2	4	14	2	2	2		2
1976							2		4	9	112	37	32	5	73	1	3	33	940	1076	99	28	39	89	20	16		1	9	6	4			1
1977										1	10	3	3	7	1				339	469	446	2	6	33	8	5	1	2	119	5			1	4
1978									1	2	95	92	32	43	1137	10	155	9	1061	266	1	3	4	12	1	1				1		1		3
1979							3		2	1	4	16	3	26	17		16		286	287	19	2	4	3				1	6	6			1	1
1980						2	2	1	28	79	45	139	13	42	24	29	75	2	186	25		50	6	38	8	2			2					3
1981						1	1		4	6	18	47	50	11	10		8	39	477	233	31	7	6	24	13	1	2					1		1
1982					38		25	2	39	72	31	24	102	216	139	22	56	13	1	3		10	8											
1983	5		20	5	22	4	28		3	1	2			1	63	3	21													1				
1984						2			3	3	6	11	9	5	13		3	3	7	3	2	1	1	1										
1985												4	1	1					18	14	2			1			1				2			
1986									2	2	8	26	2	8	7		4	2	215	65	2	1	1	3							7			
1987						1														12	30	1	8	15	1		2			1	2	1		
1988											1	3	1						21	9	10		2	5	3	1								
1989						1					1	6	2	3	3	3	8		14	95	4		3			3					1			
1990											1				5			3	52	26		1	5	5			1							1
1991																2	1		56	16	5			2	3	2		1	1					
1992											1	14		1					20	30	48		3	13								1		
1993						2	19		18	14	17	42	22	6	38		1		152	18	2		9	5										
1994						7			1		87	77	14	47	13		1	1	137	122	117	62	33	8		4			1				1	
1995		1		1	8	8	4	8	32	7	4	4	12	2	66		2		2			1												
1996				1	4	7	12	3	9	14		20	21	1	15	2	2		16	15	2	1												
1997						7				1	44	27	10	3	13				47	64	6	4		2										
1998	4		9	13	25	36	3	27	12	11	4		4	1	30	8	9	2	1					1										
1999	2				1	38	9	10	27	6	65	81	50	7	170	6	3		75	42	15	9	2	2	1	1								
2000						2	2	1	2		34	45	5	11	20	4	6	5	140	87	35	12	2	3					1	1				
2001					2		1				3	2	7	1	1			2	77	49	11	2	7	5	3	1								
2002									1		17	9		1	5				46	156	33	3		7										
2003											9	13	5	6	2	4	3	3	28	1	3	7	2	1										

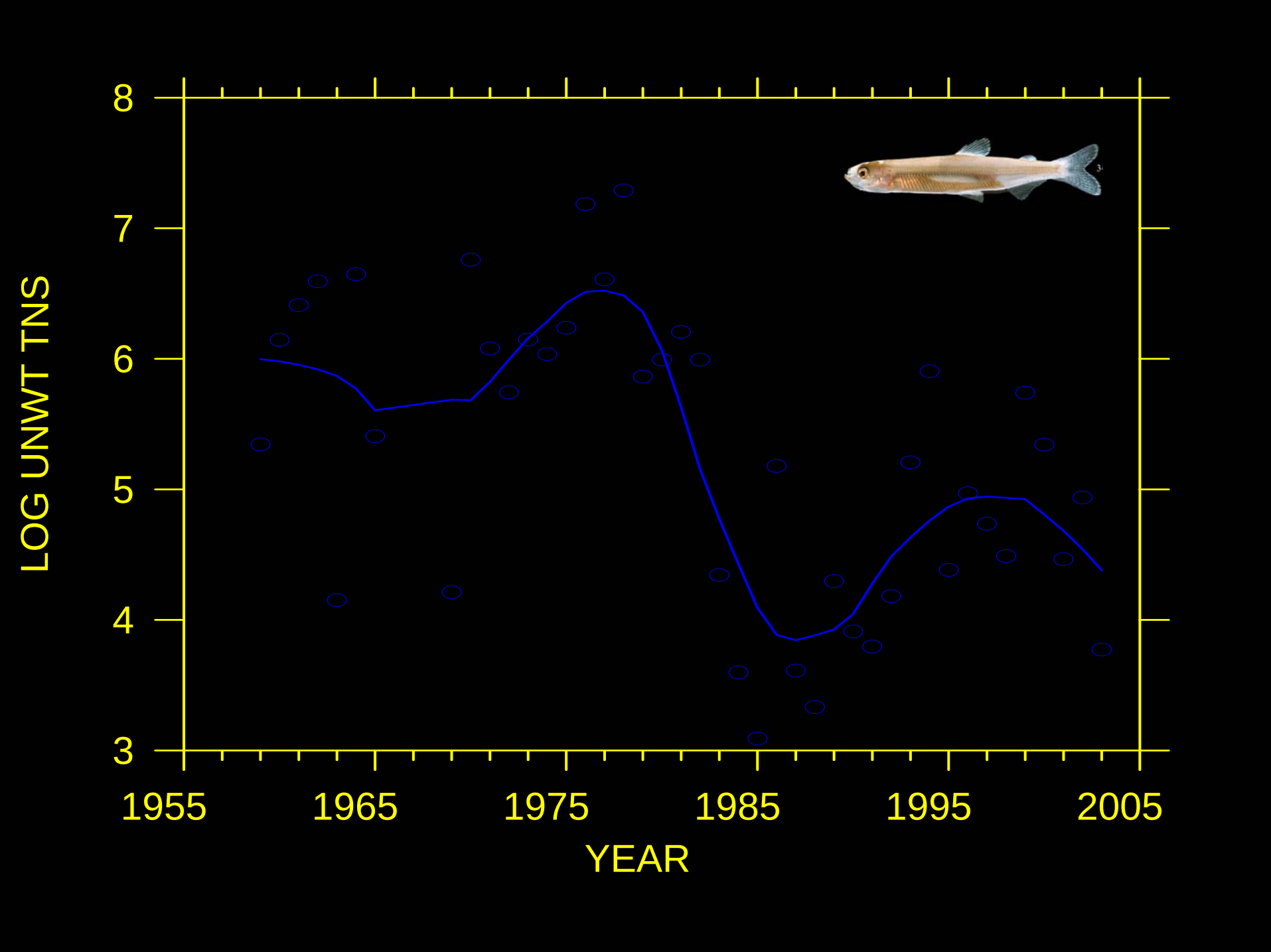
Abundance trends similar between spring and summer Juv



Log unwt TNS

Log unwt 20MM

What is happening between hatch and juvenile stage?


8
7
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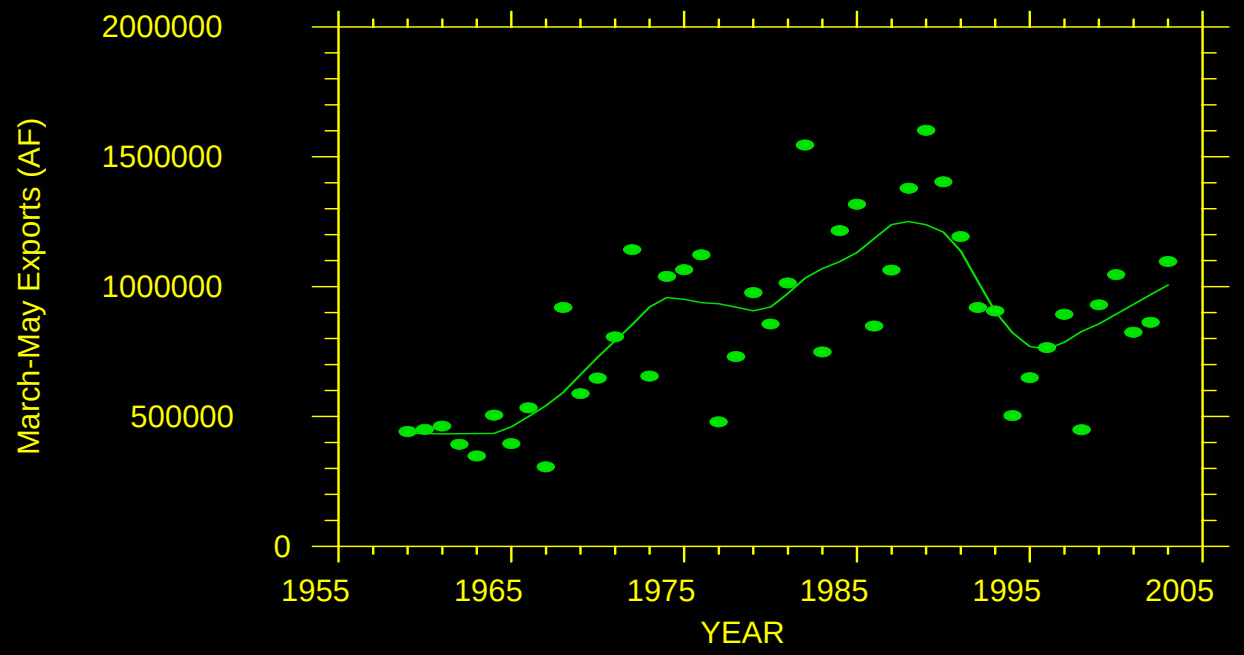
5
4
3
LOG UNWT TNS
1955
1965
1975
1985
1995
2005
YEAR


2000000
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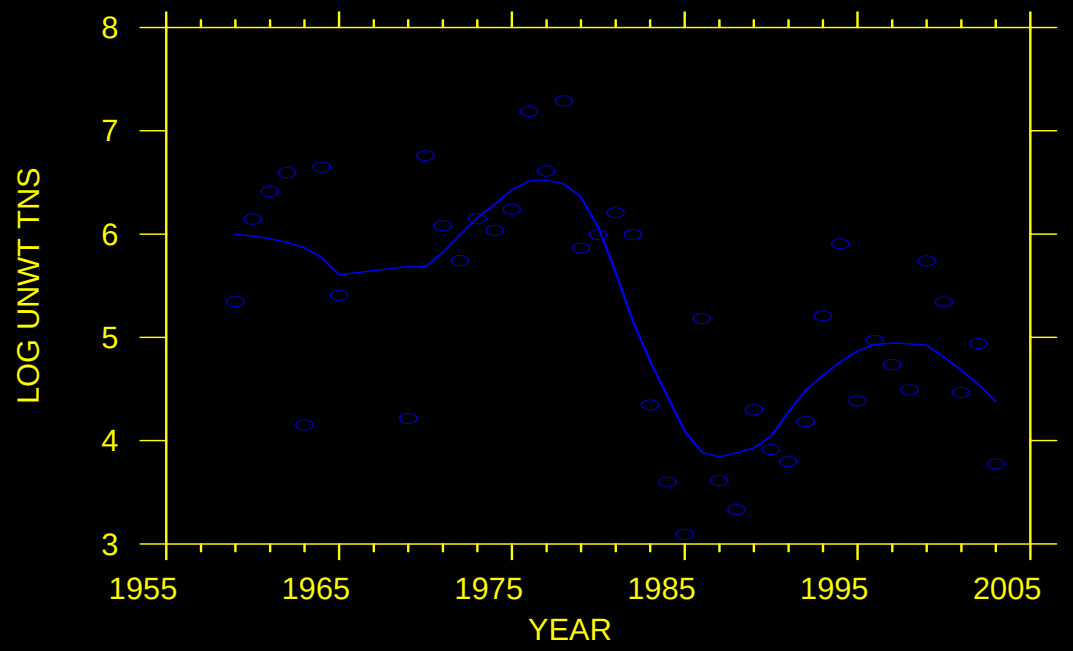
500000
0
March-May Exports (AF)
1955
1965
1975
1985
1995
2005
YEAR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LOG UNWT TNS
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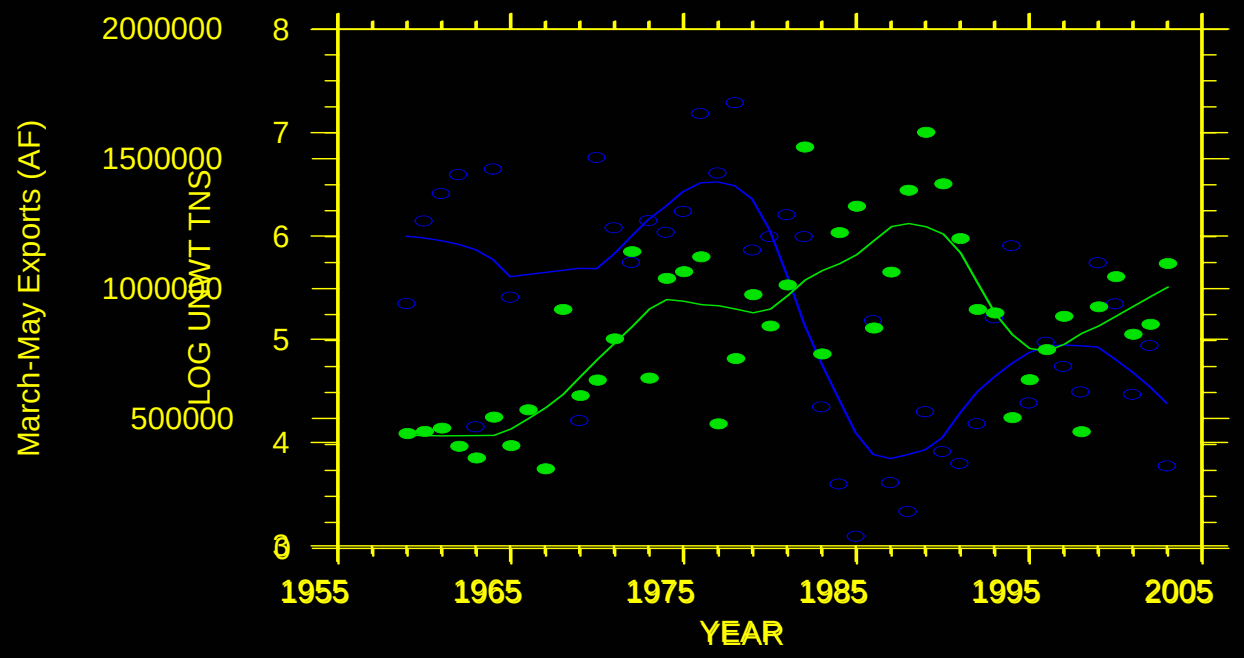
2005
YEAR


March-May Exports (AF)
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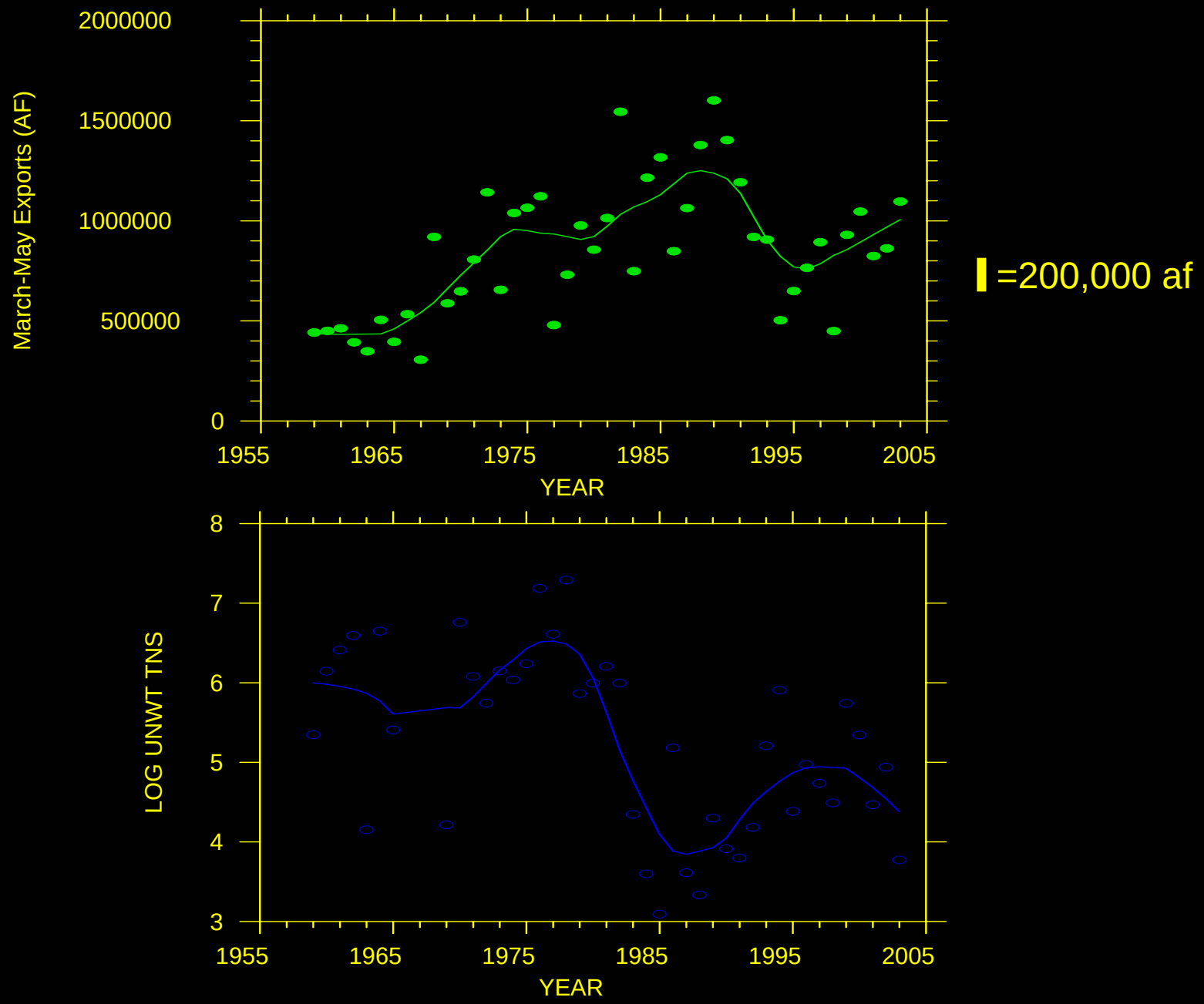
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March-May Exports (AF)
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1985
1995
2005
YEAR
=200,000 af
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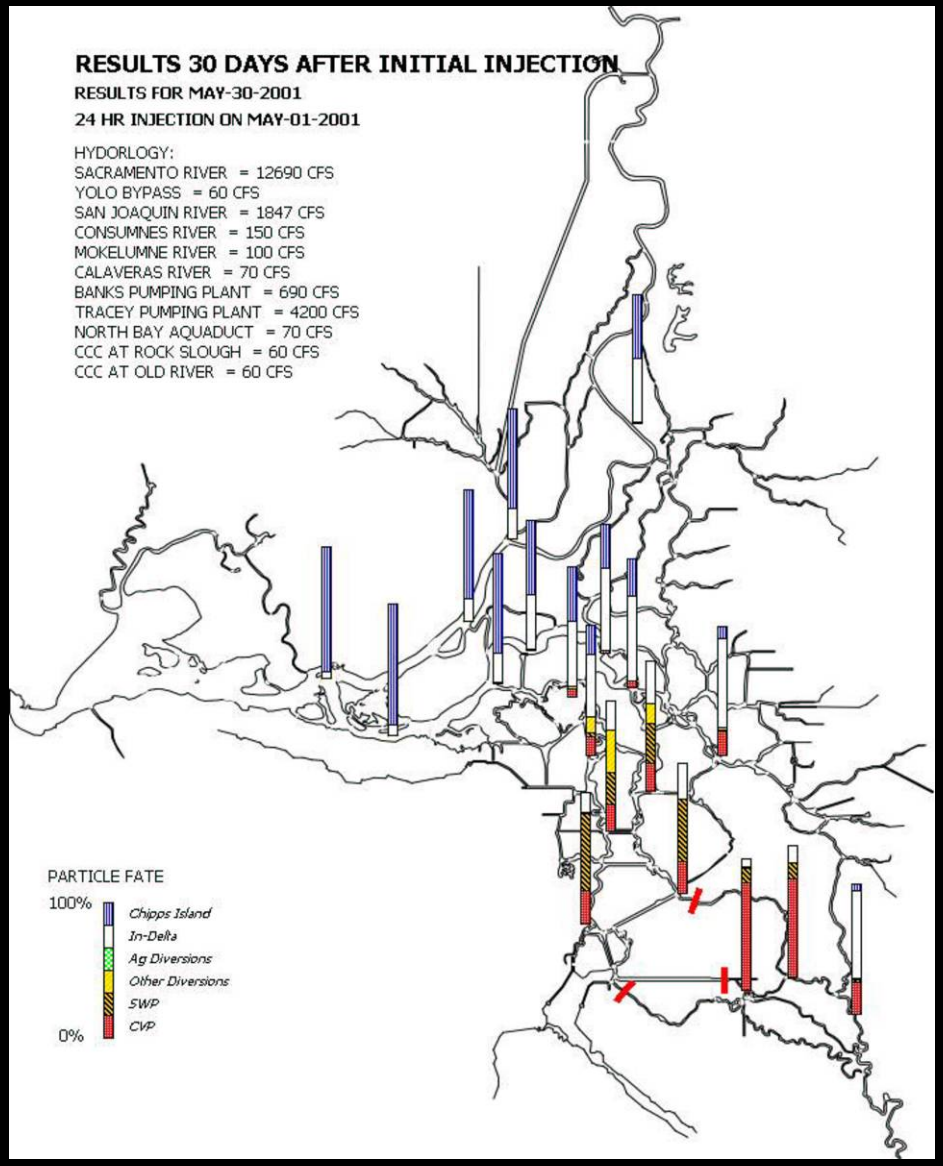
3
LOG UNWT TNS
1955
1965
1975
1985
1995
2005
YEAR

Particles in the delta end up At the facilities

A 5mm delta smelt is not as strong a swimmer as a 20mm delta smelt



What have we done and What have we learned?

•Used to avoid ESA “red light” restrictions; the focus has been on the late spring period; red light has been successfully avoided.

•Red light levels based upon historic salvage numbers and not upon smelt abundance levels

•The DSRAM attempts to make up for many of the shortfalls of the old OCAP opinion

•Delta smelt are aptly named

•The delta is not as hospitable as it once was

•Despite use of EWA and b(2) assets for VAMP, the exports during the early spring have trended upward and delta smelt abundance has trended downward

•Assets are limited and timing may be crucial

•Acquiring assets during early spring may be the wrong thing to do

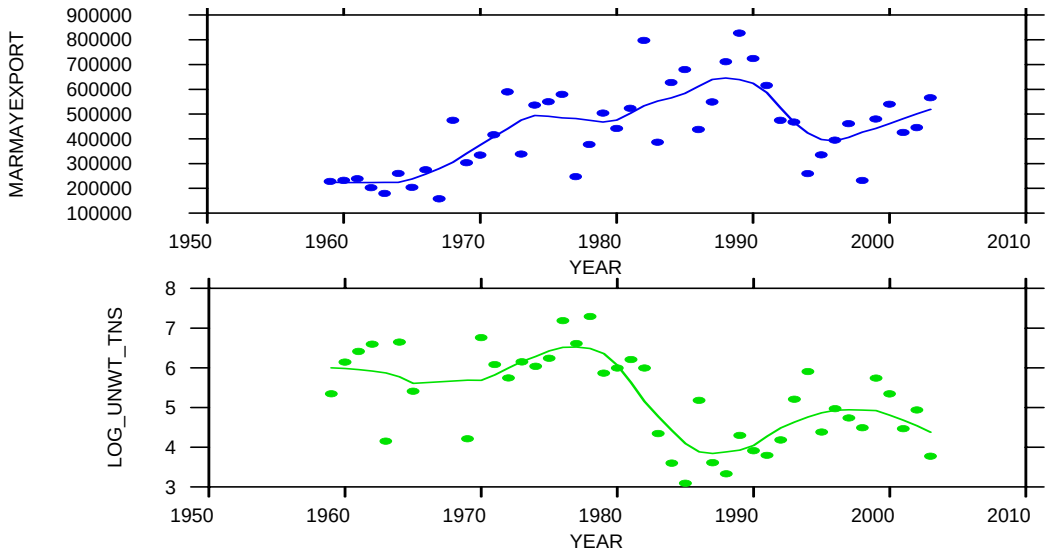
What should we do next?

- Take advantage of VAMP
  - Modify PTM radial gate operations to allow two way flow
  - Track fate of particles during VAMP with and without modification
  - Model water levels in south delta

- Refine the relationship between exports and abundance to account for the controlling factors that are environmental

- Consider pre-VAMP expenditures of EWA

- Response variable (increased delta smelt abundance)
  - Single year species should responses should be fairly immediate
  - may not be sensitive to the amount of EWA expended



Dep Var: LOG_UNWT_TNS N: 42 Multiple R: 0.370 Squared multiple R: 0.137

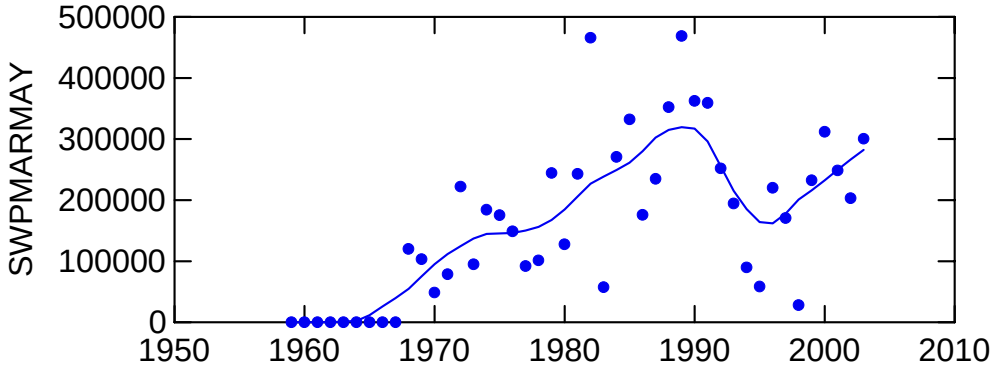
Adjusted squared multiple R: 0.116 Standard error of estimate: 1.057

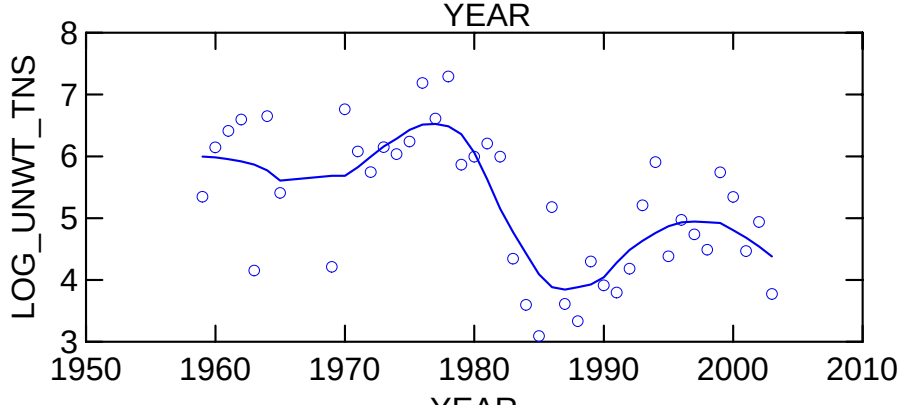
Effect	Coefficient	Std Error	Std Coef	Tolerance	t	P(2 Tail)
CONSTANT	6.337	0.463	0.000	.	13.702	0.000
MARMAYEXPORT	-0.000	0.000	-0.370	1.000	-2.521	0.016

Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
Regression	7.096	1	7.096	6.355	0.016
Residual	44.660	40	1.117		

Durbin-Watson D Statistic 1.191
First Order Autocorrelation 0.387





Dep Var: LOG_UNWT_TNS N: 42 Multiple R: 0.455 Squared multiple R: 0.207

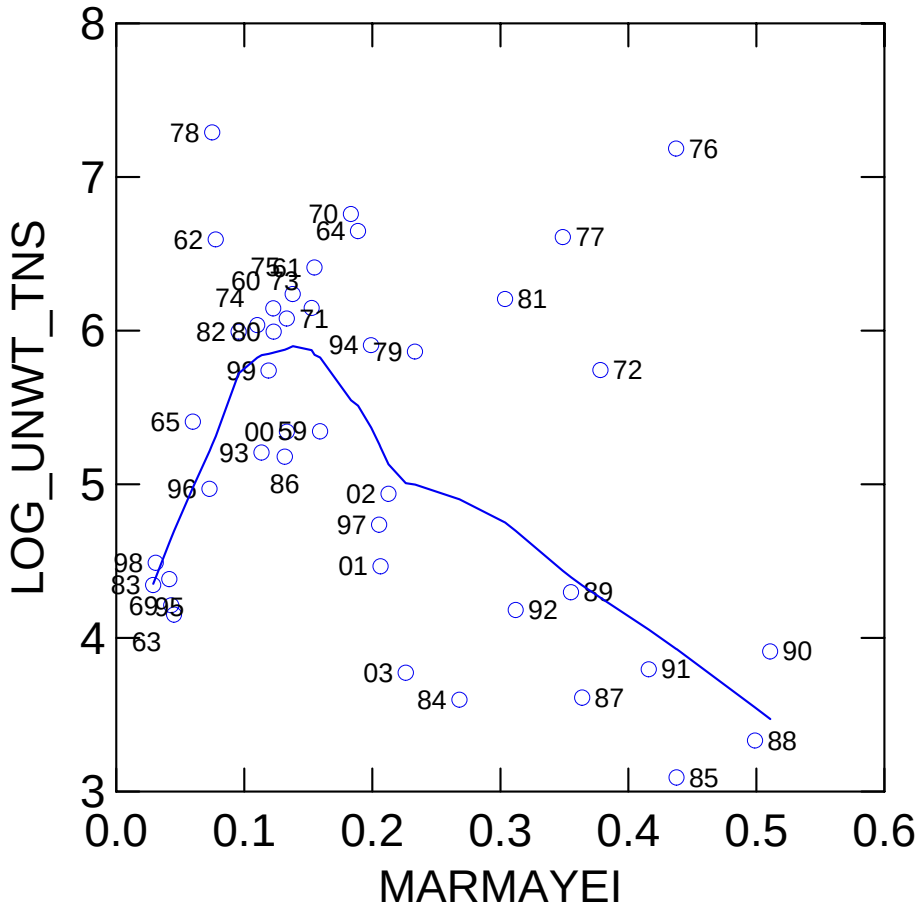
Adjusted squared multiple R: 0.187 Standard error of estimate: 1.013

Effect	Coefficient	Std Error	Std Coef	Tolerance	t	P(2 Tail)
CONSTANT	5.924	0.262	0.000	.	22.641	0.000
SWPMARMAY	-0.000	0.000	-0.455	1.000	-3.230	0.002

Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
Regression	10.705	1	10.705	10.431	0.002
Residual	41.051	40	1.026		

Durbin-Watson D Statistic 1.313
First Order Autocorrelation 0.328


LOG_UNWT_TNS
MARMAYEI
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99
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00
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86
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02
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