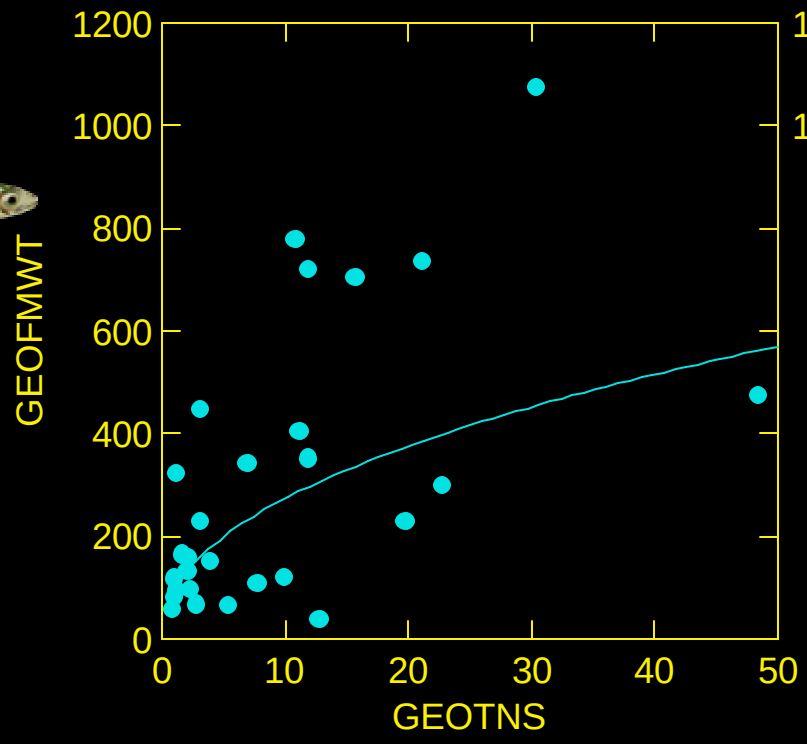
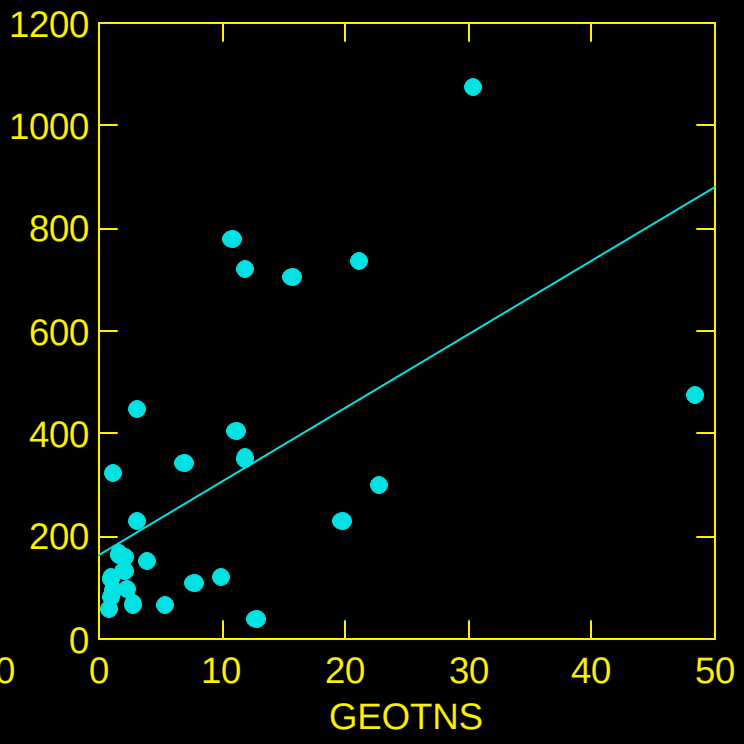
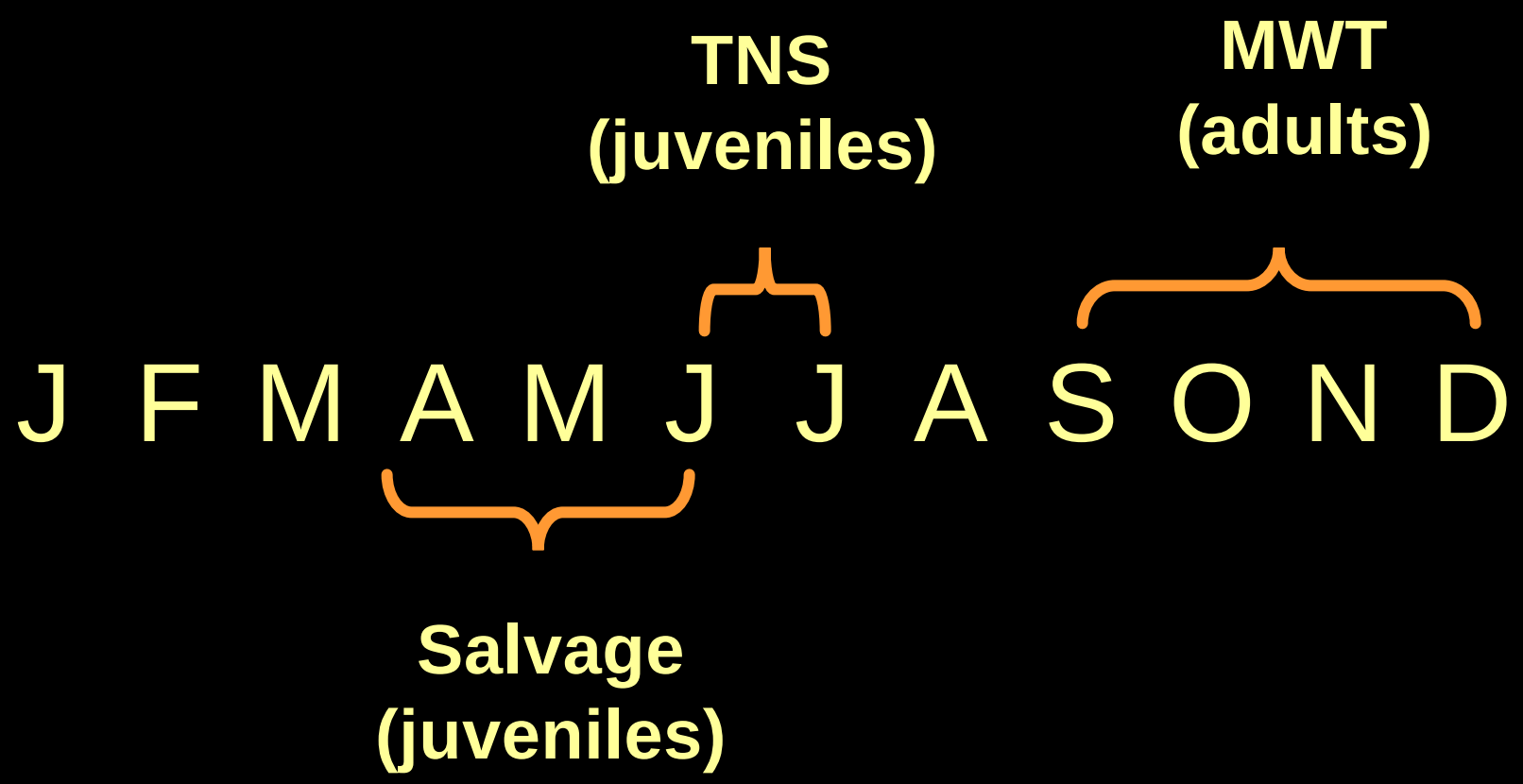
How should we treat carrying capacity and density dependence in developing water management strategies that minimize impacts to delta smelt?

Density Dependence vs. Density Independence

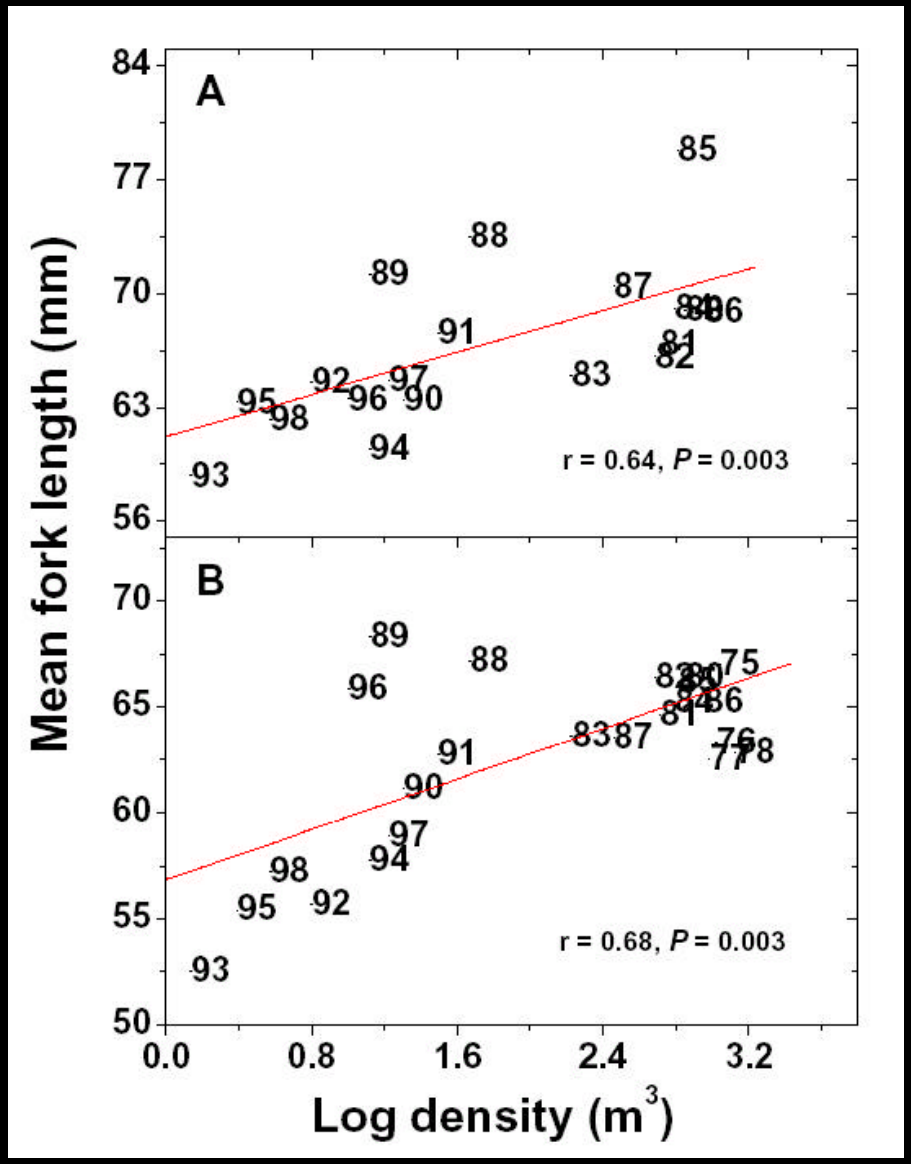




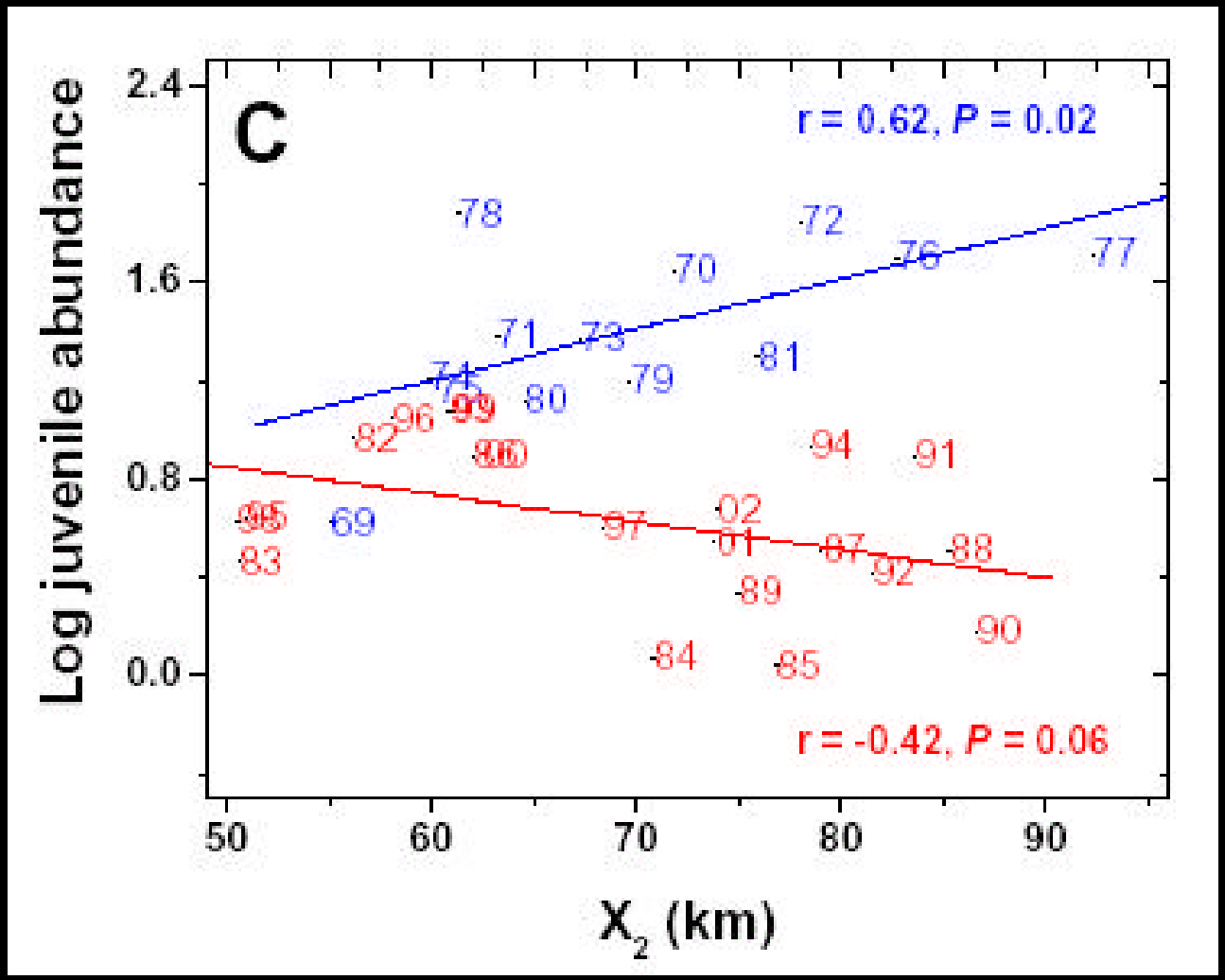
Timing



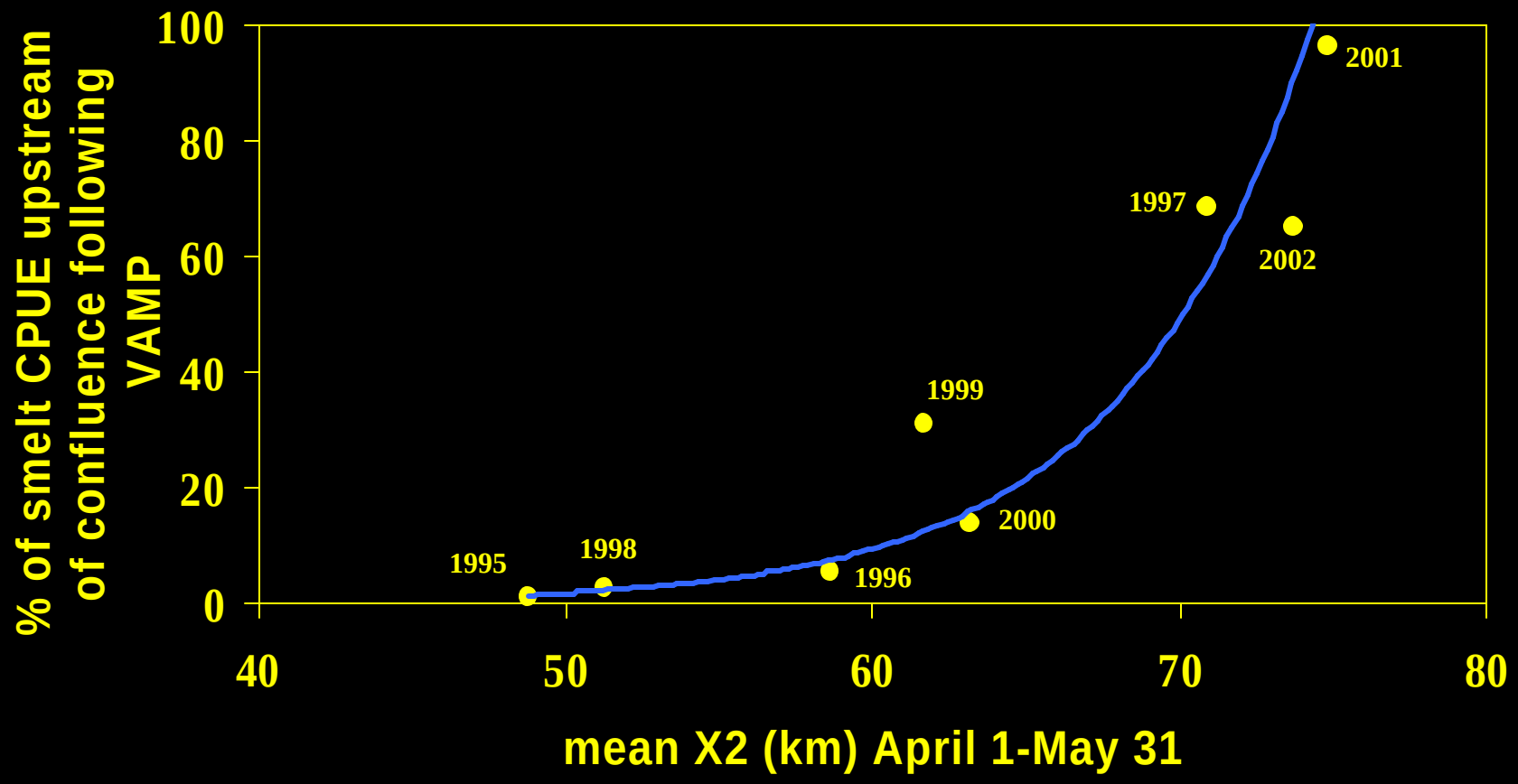
Manage carrying capacity



- Huge differences in food (3 – 1590m^3)
- Lead to a difference of 10mm TL
- Result in undetectable increases fecundity

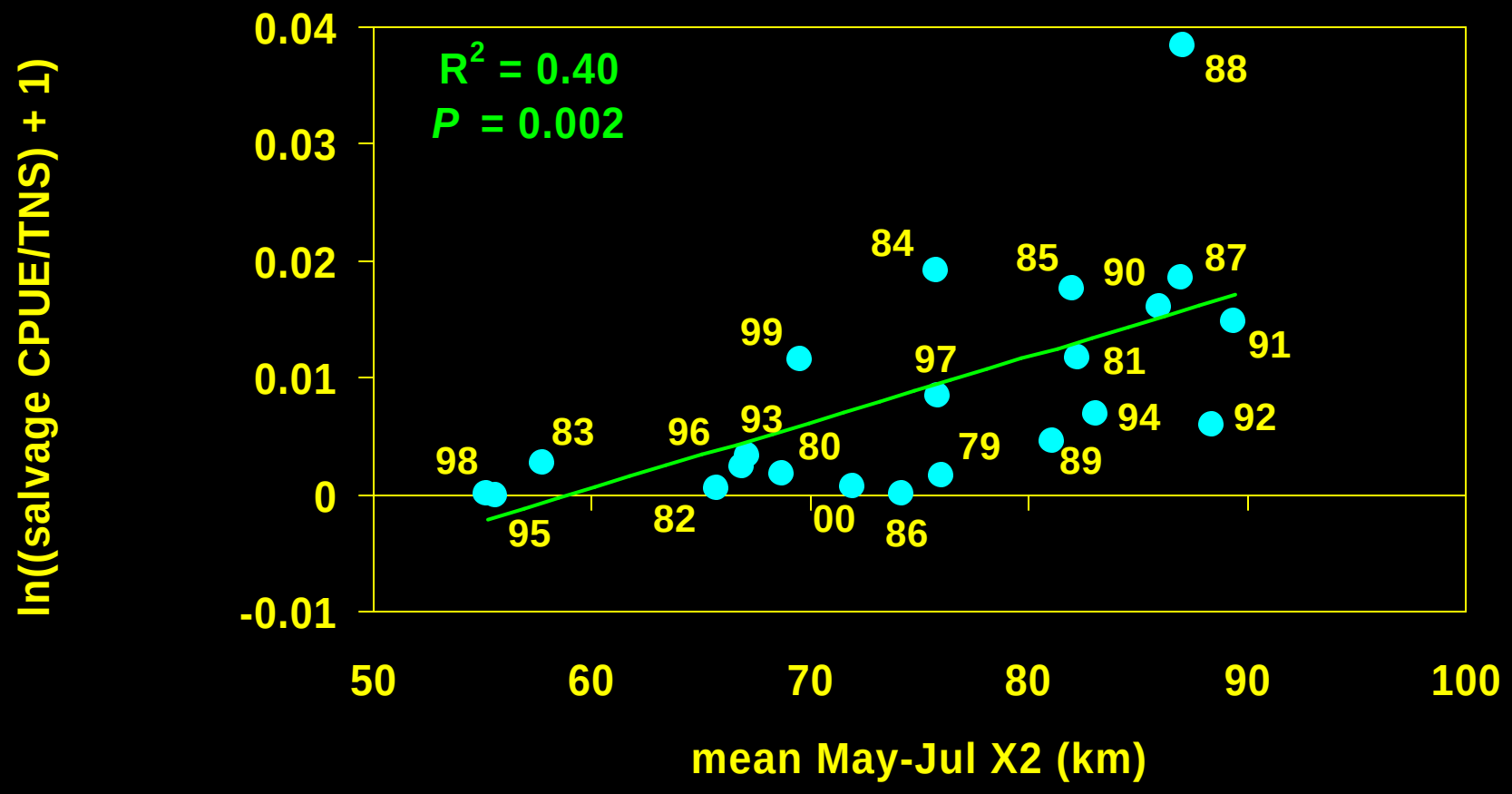

C
r = 0.62, P = 0.02
r = -0.42, P = 0.06
Log juvenile abundance
X2 (km)
2.4
1.6
0.8
0.0
50
60
70
80
90
78
72
76
77
70
71
73
81
79
80
96
82
94
91
69
97
02
01
87
88
83
92
89
90
84
85

Post-larval macro-distribution

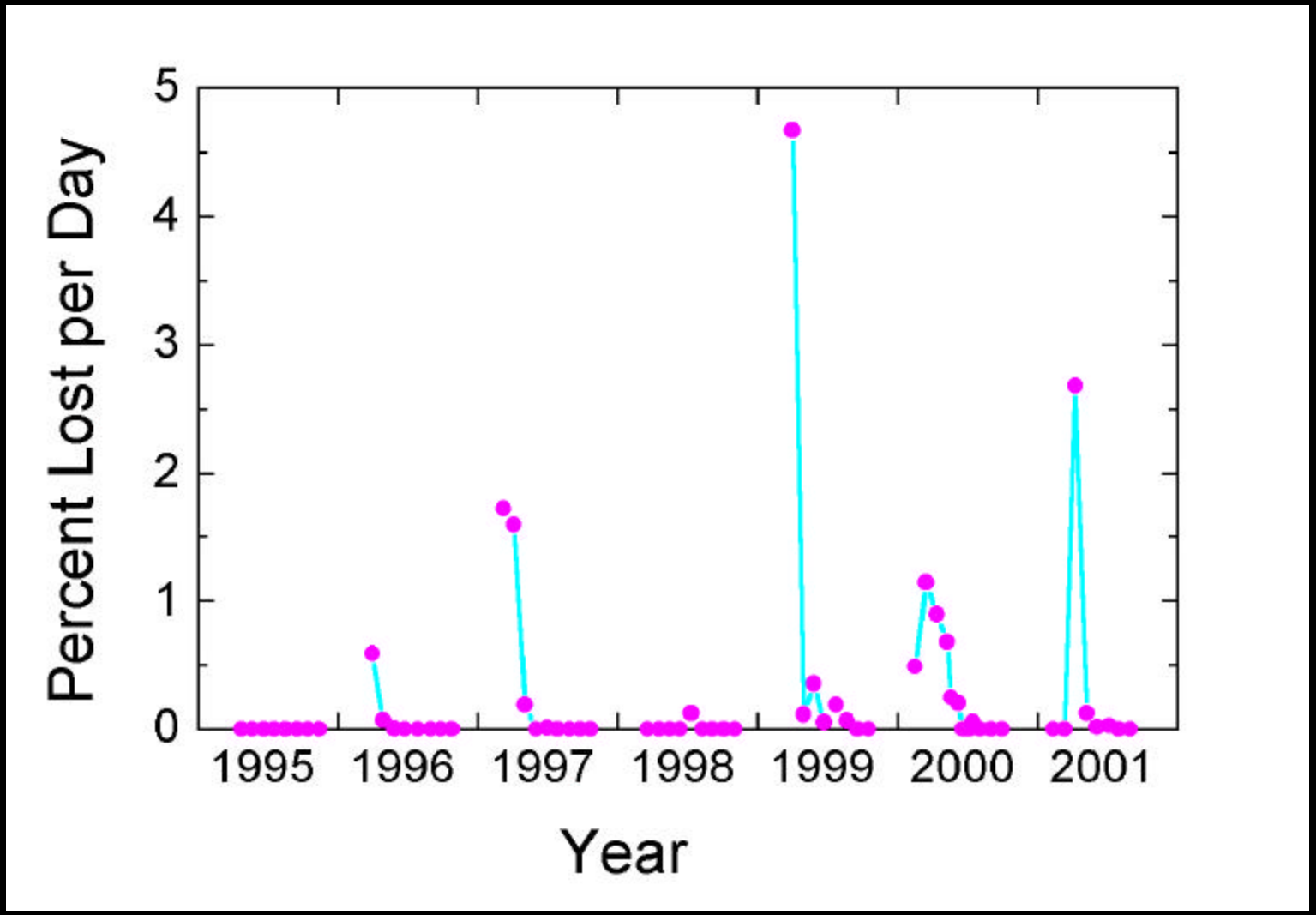


Nobriga, DWR

YOY salvage



Nobriga, DWR

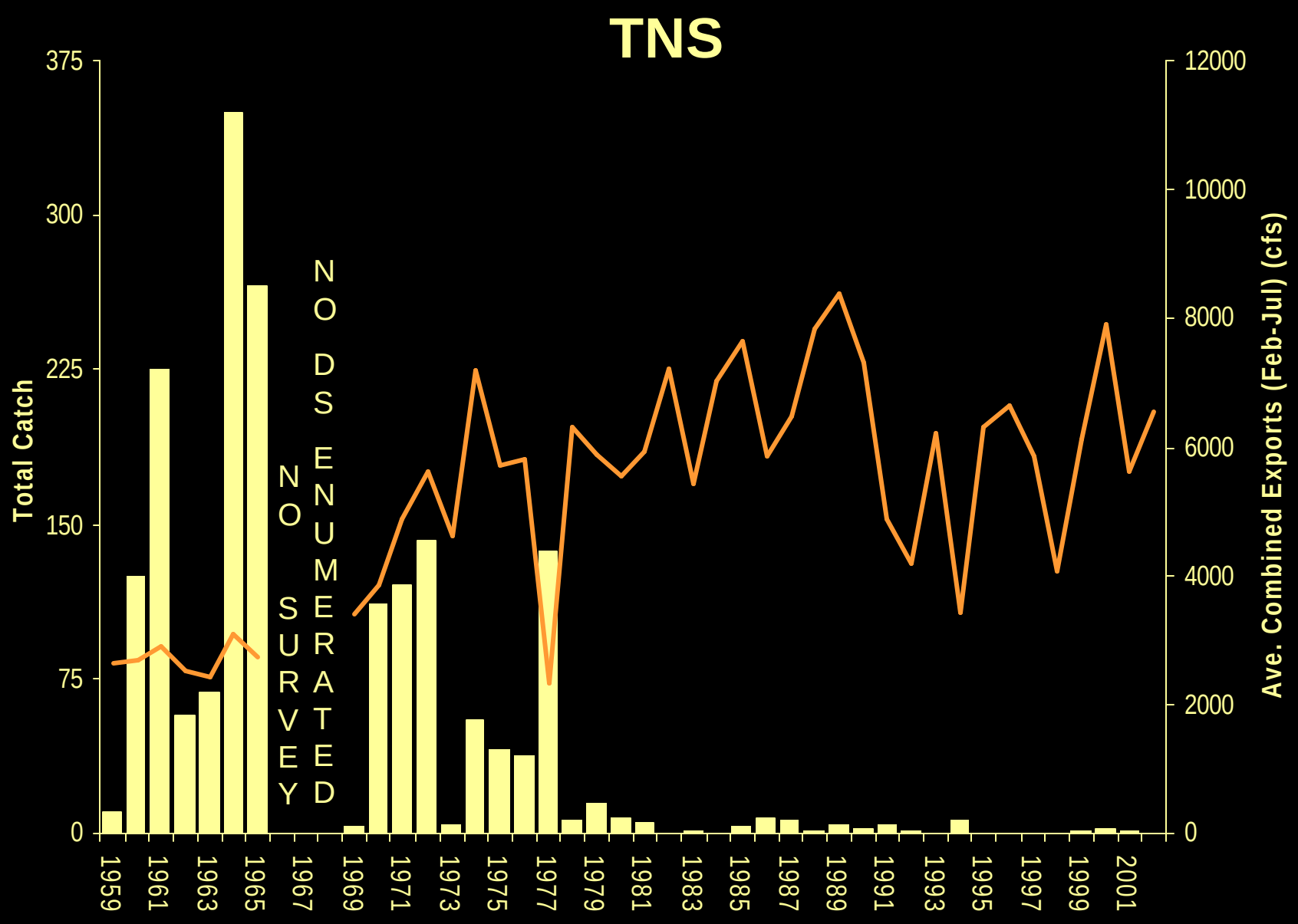


Kimmerer, RTC

TNS CATCH

South Delta

	323	340	405	411	418	501	504	508	513	519	520	602	606	609	610	704	706	707	711	801	804	809	812	815	902	906	910	912	914	915	918	919
1959									18		1					224		105	26		1	27	7	5		1	4					
1960			10				2		37	11	4	5	4	7	4	599		46	35		4	28	11	46	3	42	26		5	3		
1961			2				2		9	4	3	33	47	139	61	235		147	180		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	89	4		87	26	14		5	9	4	7	1	1	16
1963					1	1		5		2	2	8	1	9	4	2	3	1	1	3	9	5	1	19	1	23	14		7	1		4
1964			2				2	4	4		4	2			3	274	301	409	35	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	2	8	29	7	6	57	14	116	18	1	30	14	12	4
1966	NO SURVEY																															
1967	NO DELTA SMELT ENUMERATED																															
1968																																
1969			5	6	1	18	3	5	4	5		57	3	14	5	2			2		1		1	1								2
1970						3	6	19	12	3	11	2			12	596	403	440	29	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	18	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		1
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	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	1	62	33	8		4			1				1	
1995		8	8	4	8	32	7	4	4	12	2	66		2		2				1												
1996		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	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	1	3		7										


TNS
Total Catch
Ave. Combined Exports (Feb-Jul) (cfs)
375
300
225
150
75
0
12000
10000
8000
6000
4000
2000
0
NO SURVEY
NO DS ENUMERATED
1959
1961
1963
1965
1967
1969
1971
1973
1975
1977
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997
1999
2001