

Survival estimates using MARK for Imperial Ponds razorback sucker populations



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Marsh

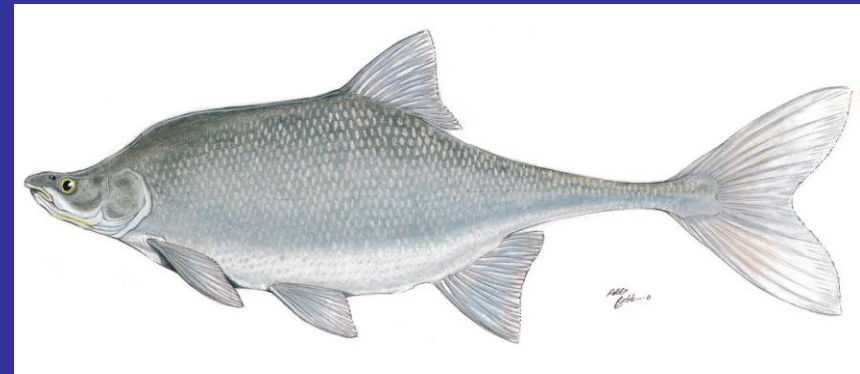
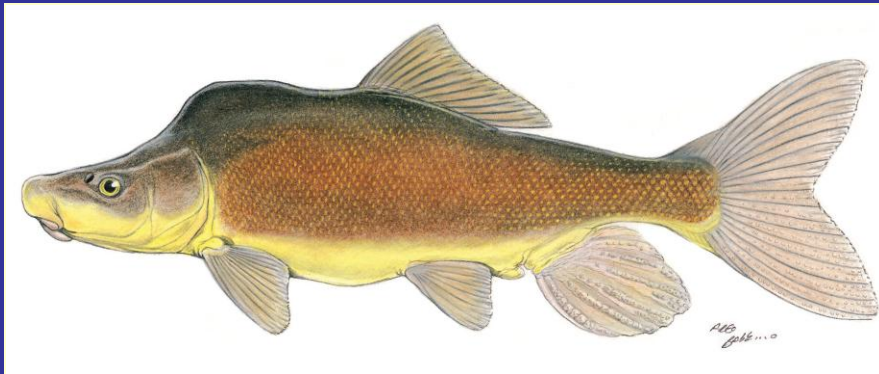
Study Area

- Imperial National Wildlife Refuge
- 6 Pond Complex



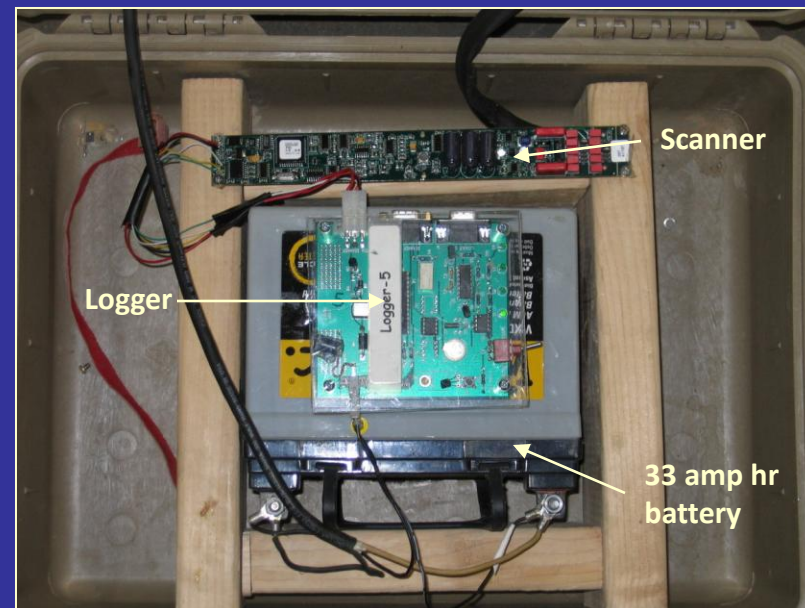
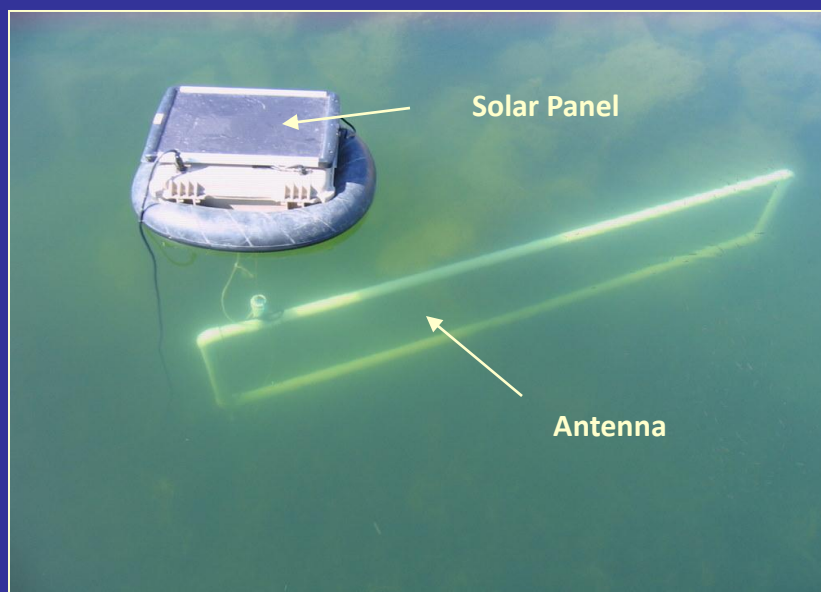
Off-channel habitats

- Conserve genetic viability and prevent extinction
- Increase habitat for endangered native fish
- Study all aspect of native fish life cycle



Remote Sensing

- Remote Sensing Units
 - Allflex scanner in 1520 Pelican cases
 - 2.3 m x 0.7 m antenna



- Standard Effort
 - Monthly sampling
 - 24 hour period
 - 4 remote sensing units

Program MARK

- MARK Modeling software
 - Input encounter histories
 - Cormack-Jolly-Seber Model
 - Two parameters apparent survival probability (Φ) and encounter probability (p)
 - Parameters can vary over time or can remain constant
 - All encounter (p) probabilities allow to vary over time
 - Only present apparent survival probability (Φ) values

Populations Modeled

- Pond 4 (FDX tags)
272 fish in Dec 2007



Populations Modeled

- Pond 2 (HDX tags)
59 fish in stocked Dec 2008



Populations Modeled

- Pond 6 (HDX tags)
198 fish in stocked Jan 2009



Pond 4 Totals table

Sampling Events	Month	Contacts
Stocking	Nov 5, 2007	272
1-2	Apr 12, 2008-Apr 16, 2008	14
2-3	Aug 18, 2008-Aug 21, 2008	38
3-4	Oct 20, 2008-Oct 24, 2008	59
4-5	Jan 27, 2009-Jan 29, 2009	93
5-6	Feb 10, 2009-Feb 12, 2009	90
6-7	Apr 01, 2009-Apr 03, 2009	59
7-8	May 11, 2009-May 14, 2009	41
8-9	Jun 22, 2009-Jun 25, 2009	66
9-10	Jul 20, 2009-Jul 21, 2009	28
10-11	Aug 24, 2009-Aug 27, 2009	1
11-12	Oct 19, 2009-Oct 22, 2009	4
12-13	Nov 9, 2009-Nov 13, 2009	26
13-14	Dec 14, 2009-Dec 18, 2009	12

Sampling Events	Month	Contacts
14-15	Jan 4, 2010-Jan 08, 2010	16
15-16	Jan 19, 2010-Jan 22, 2010	19
16-17	Feb 1, 2010-Feb 5, 2010	15
17-18	Feb 16, 2010-Feb 19, 2010	17
18-19	Mar 1, 2010-Mar 5, 2010	29
19-20	Mar 29, 2010-Apr 2, 2010	7
20-21	Apr 12, 2010-Apr 16, 2010	23
21-22	Apr 26, 2010-Apr 30, 2010	3
22-23	May 24, 2010-May 28, 2010	1
23-24	Jun 7, 2010-Jun 11, 2010	5
24-25	Jun 20, 2010-Jun 23, 2010	1
25-26	Jul 5, 2010-Jul 8, 2010	2
26-27	Jul 19, 2010-Jul 22, 2010	8
27-28	Aug 16, 2010-Aug 20, 2010	4

Model Selection Pond 4

Model Number	Model	k	AICc	Model Likelihood	Deviance
1	Phi(Oct+Constant) p(t)	29	2855.73	1.0000	945.22
2	Phi (Aug-Oct+Constant) p(t)	29	2856.21	0.7332	945.70
3	Phi(Jul-Aug+Constant) p(t)	29	2558.48	0.2527	947.97
4	Phi(t) p(t)	53	2886.62	0.0000	923.63
5	Phi (Jun-Aug) p(t)	29	2898.58	0.0000	988.07
6	Phi (2 summers+constant) p(t)	30	2900.66	0.0000	988.02

Pond 4 Best Model Estimates

Sampling Event	Interval	Phi	Interval survival	Cumulative Survival	Inferred Population Size
Stocking					272.00
1-2	5.4	0.9663	0.832	0.832	226.29
2-3	4.3	0.9663	0.864	0.719	195.61
3-4	2.1	0.9663	0.930	0.774	181.92
4-5	3.3	0.9663	0.894	0.744	162.65
5-6	0.5	0.9663	0.984	0.819	160.07
6-7	1.7	0.9663	0.944	0.786	151.18
7-8	1.4	0.9663	0.955	0.794	144.34
8-9	1.4	0.9663	0.953	0.793	137.58
9-10	0.9	0.9663	0.970	0.807	133.40
10-11	1.2	0.9663	0.960	0.798	128.02
11-12	1.9	0.4896	0.260	0.216	33.30
12-13	0.7	0.9663	0.976	0.812	32.49
13-14	1.2	0.9663	0.961	0.799	31.22

Introduction

Methods

Results

Discussion

Conclusion

Pond 4 Best Model Estimates

Sampling Events	Interval	Phi	Interval survival	Cumulative Survival	Inferred Population Size
14-15	0.7	0.9663	0.976	0.812	30.48
15-16	0.5	0.9663	0.984	0.818	29.98
16-17	0.5	0.9663	0.985	0.819	29.52
17-18	0.5	0.9663	0.984	0.818	29.03
18-19	0.5	0.9663	0.985	0.819	28.59
19-20	0.9	0.9663	0.969	0.806	27.69
20-21	0.5	0.9663	0.984	0.819	27.25
21-22	0.5	0.9663	0.984	0.819	26.82
22-23	0.9	0.9663	0.969	0.806	25.97
23-24	0.5	0.9663	0.984	0.819	25.56
24-25	0.4	0.9663	0.986	0.820	25.20
25-26	0.5	0.9663	0.983	0.818	24.77
26-27	0.5	0.9663	0.984	0.819	24.38
27-28	1.0	0.9663	0.968	0.805	23.60

Introduction

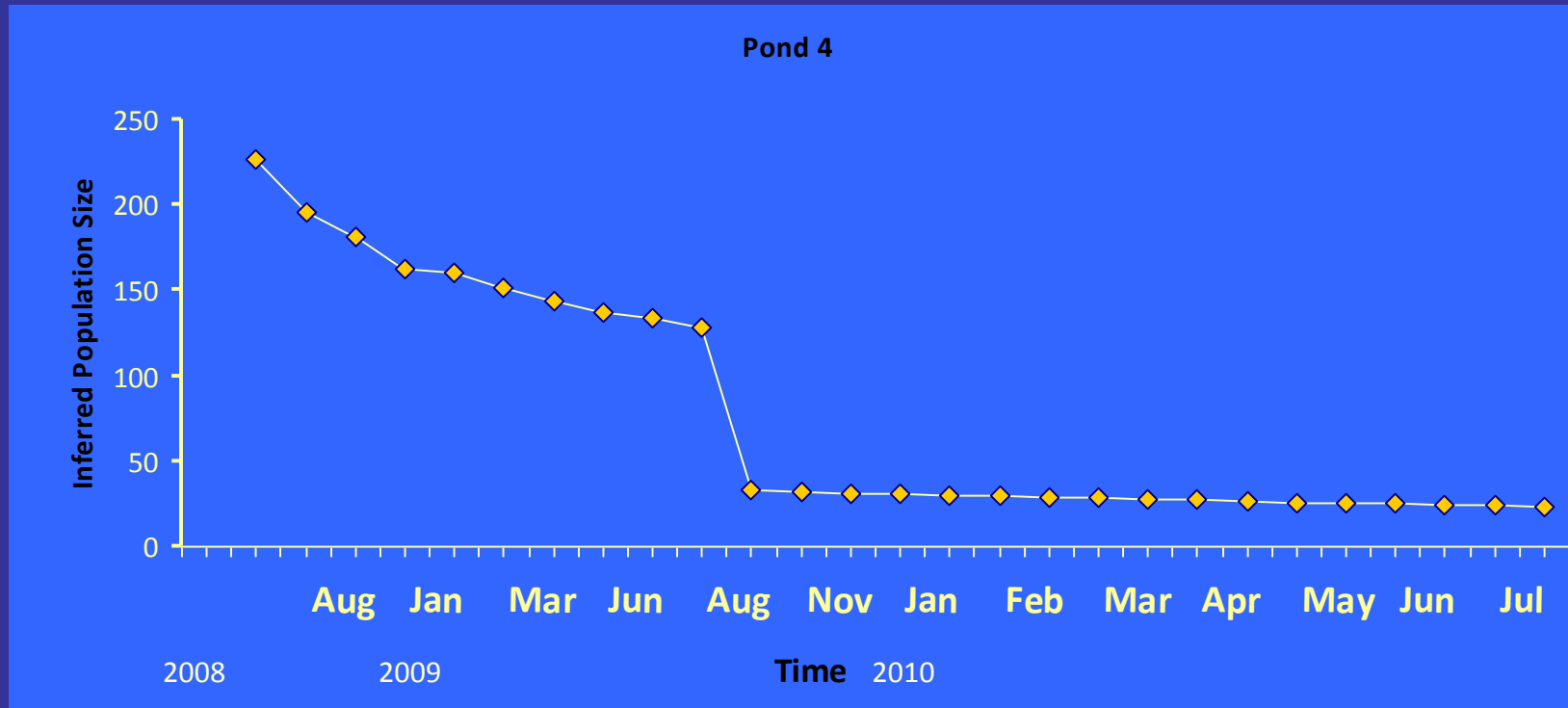
Methods

Results

Discussion

Conclusion

Pond 4 Population Graph



Pond 2 Totals Table

Sampling Events	Month	Total Contacts
Stocked	December 12, 2008	59
1-2	Jan 13, 2009-Jan 16, 2009	20
2-3	Feb 23, 2009-Feb 26,2009	52
3-4	Apr 13, 2009- Apr 16,2009	50
4-5	Apr 27, 2009- Apr 30,2009	28
5-6	May 25,2009-May 28,2009	50
6-7	Jul 8, 2009-Jul 10, 2009	41
7-8	Aug 10, 2009-Aug13,2009	5
8-9	Aug 24, 2009-Aug 27,2009	7
9-10	Sep 21, 2009-Sep 24, 2010	28
10-11	Oct 19, 2009-Oct22,2009	31
11-12	Nov 9, 2009-Nov 13, 2009	13
12-13	Dec 14, 2009- Dec 18, 2009	35
13-14	Jan 4, 2010-Jan 8, 2010	35
14-15	Jan 19, 2010-Jan 22, 2010	41

Sampling Events	Month	Total Contacts
14-15	Jan 19, 2010-Jan 22, 2010	41
15-16	Feb 1, 2010-Feb 5,2010	44
16-17	Feb 16,2010-Feb 19,2010	46
17-18	Mar 1,2010-Mar 5,2010	42
18-19	Mar 29,2010-Apr 2,2010	46
19-20	Apr 12,2010-Apr 16,2010	41
20-21	Apr 26,2010-Apr 30,2010	40
21-22	May 10,2010-May 13,2010	1
22-23	May 24,2010-May 28,2010	35
23-24	Jun 7,2010-Jun 11,2010	31
24-25	Jun 20,2010-Jun 23,2010	27
25-26	Jul 5, 2010-Jul 8, 2010	2
26-27	Jul 19, 2010-Jul 22,2010	17
27-28	Aug 16, 2010-Aug 20,2010	11

Model Selection Pond 2

Model Number	Model	k	AICc	Model Likelihood	Deviance
1	Phi(.) p(t)	28	1247.08	1.0000	720.13
2	Phi(t) p(t)	53	12803.04	0.0000	697.99

Pond 2 Best Model Estimates

	Sampling Events	Interval	Phi	Interval Survival	Cumilitavive Survival	Inferred Population Size
	Stocked					59.00
	1-2	1.2	0.9851	0.982	0.982	57.96
	2-3	1.4	0.9851	0.980	0.962	56.79
	3-4	1.6	0.9851	0.976	0.959	55.41
	4-5	0.5	0.9851	0.993	0.976	55.03
	5-6	0.9	0.9851	0.986	0.969	54.26
	6-7	1.5	0.9851	0.978	0.961	53.09
	7-8	1.1	0.9851	0.983	0.966	52.21
	8-9	0.5	0.9851	0.993	0.976	51.85
	9-10	0.9	0.9851	0.986	0.969	51.13
	10-11	0.9	0.9851	0.986	0.969	50.42
	11-12	0.7	0.9851	0.989	0.972	49.88
	12-13	1.2	0.9851	0.983	0.965	49.01
	13-14	0.7	0.9851	0.990	0.972	48.50

Introduction

Methods

Results

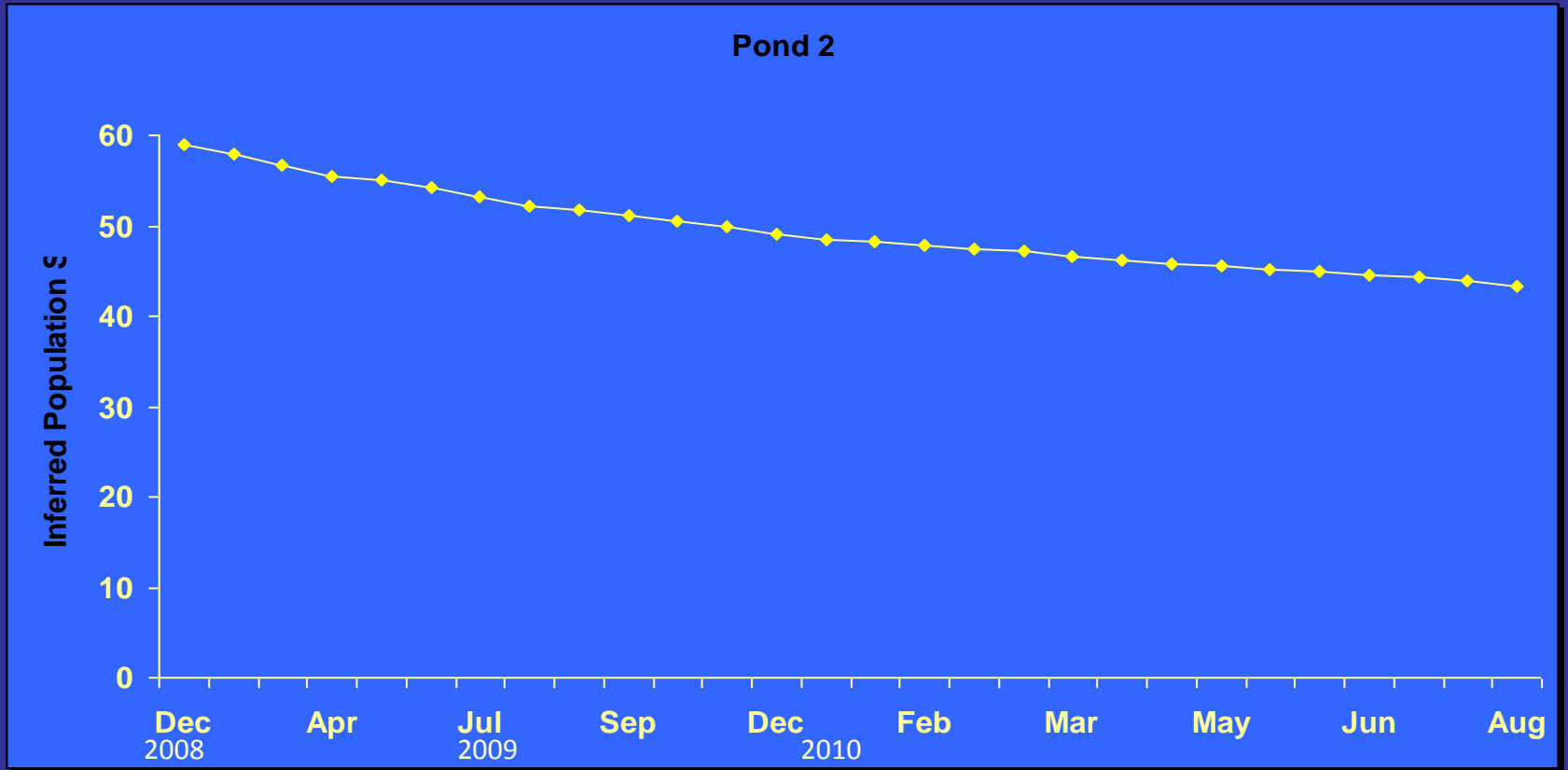
Discussion

Conclusion

Pond 2 Best Model Estimates

Sampling Intervals	Interval	Phi	Interval Survival	Cumulative Survival	Inferred Population Size
14-15	0.5	0.9851	0.993	0.975	48.15
15-16	0.5	0.9851	0.993	0.976	47.83
16-17	0.5	0.9851	0.993	0.975	47.48
17-18	0.5	0.9851	0.993	0.976	47.16
18-19	0.9	0.9851	0.986	0.969	46.51
19-20	0.5	0.9851	0.993	0.976	46.18
20-21	0.5	0.9851	0.993	0.976	45.86
21-22	0.5	0.9851	0.993	0.976	45.55
22-23	0.5	0.9851	0.993	0.975	45.22
23-24	0.5	0.9851	0.993	0.976	44.91
24-25	0.4	0.9851	0.994	0.976	44.63
25-26	0.5	0.9851	0.993	0.975	44.29
26-27	0.5	0.9851	0.993	0.976	43.98
27-28	1.0	0.9851	0.986	0.969	43.36

Pond 2 Population Graph



Pond 6 Totals Table

Sampling Events	Month	Unique Contacts
1	Jan 13, 2009-Jan 16, 2009	47
2	Mar 10, 2009-Mar 13, 2009	38
3	Apr 27, 2009-Apr 30, 2009	41
4	Jun 8, 2009-Jun 11, 2009	54
5	Jul 20, 2009-Jul 21, 2009	26
6	Aug 10, 2009-Aug 13, 2009	28
7	Sept 8, 2009-Sept 11, 2009	21
8	Oct 5, 2009-Oct 9, 2009	34
9	Nov 9, 2009-Nov 13, 2009	36
10	Dec 14, 2009-Dec 18, 2009	42
11	Jan 4, 2010-Jan 8,2010	47
12	Feb 01, 2010-Feb 5, 2010	39
13	Mar 1, 2010-Mar 5, 2010	42
14	Apr 12, 2010-Apr 16, 2010	45
15	May 10, 2010-May 05, 2010	44
16	Jun 7, 2010-Jun 11, 2010	24
17	Jul 05, 2010-Jul 08, 2010	25
18	Aug 2, 2010-Aug 5, 2010	5

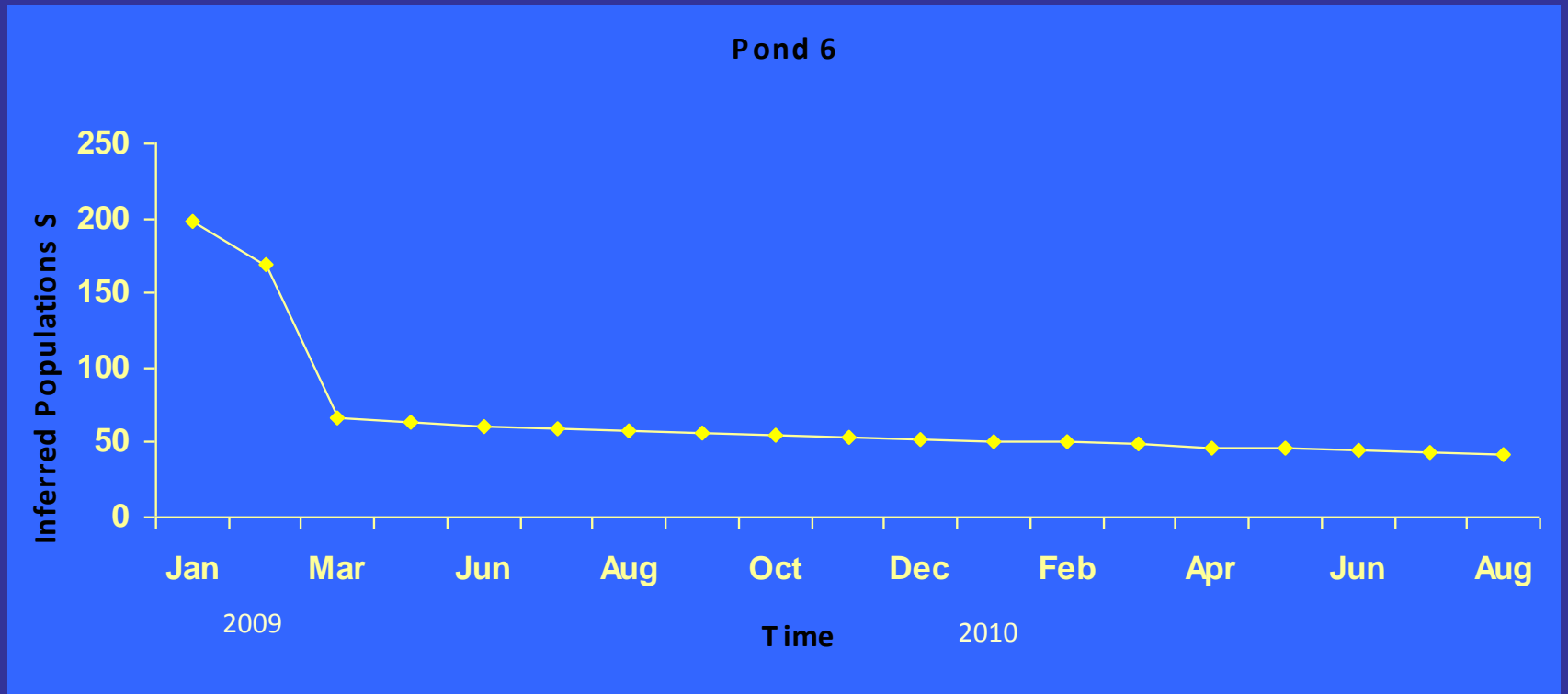
Model Selection Pond 6

Model Number	Model	k	AICc	Model Likelihood	Deviance
1	Phi (Jan-Mar+Constant) p(t)	20	1556.30	1.0000	600.77
2	Phi(Jan+Mar+Constant) p(t)	21	1556.92	0.7332	599.59
3	Phi(t) p(t)	35	1567.24	0.0024	579.58
4	Phi(Jan) p(t)	20	1639.67	0.0000	684.14

Pond 6 Best Model Estimates

Sampling Events	Interval	Phi	Interval Survival	Cumulative Survival	Inferred survival
Stocked					198
1-2	0.3	0.6062	0.853	0.853	168.97
2-3	1.9	0.6062	0.393	0.335	66.37
3-4	1.6	0.9743	0.959	0.322	63.66
4-5	1.4	0.9743	0.964	0.310	61.38
5-6	1.4	0.9743	0.965	0.299	59.23
6-7	0.7	0.9743	0.981	0.293	58.11
7-8	1.0	0.9743	0.975	0.286	56.66
8-9	0.9	0.9743	0.976	0.279	55.32
9-10	1.2	0.9743	0.970	0.271	53.66
10-11	1.2	0.9743	0.970	0.263	52.05
11-12	0.7	0.9743	0.982	0.258	51.11
12-13	0.9	0.9743	0.976	0.252	49.88
13-14	0.9	0.9743	0.976	0.246	48.68
14-15	1.4	0.9743	0.964	0.237	46.94
15-16	0.9	0.9743	0.976	0.231	45.83
16-17	1.0	0.9743	0.976	0.226	44.71
17-18	0.9	0.9743	0.976	0.220	43.65
18-19	0.9	0.9743	0.976	0.215	42.60

Pond 6 Population Graph



Conclusion

- Survival High
 - Phi (Survival Parameter)
 - Pond 2: 0.9851
 - Pond 4: 0.9663
 - Pond 6: 0.9743
- Mortality Events
 - Phi (Survival Parameter)
 - Pond 4: 0.4861 (Late Summer Mortality)
 - Pond 6: 0.6062 (Stocking Mortality)

Conclusion

- Lincoln Peterson Estimates
 - Pond 2
 - October 2010 Population Estimate : 47 CI 32-59*
 - Inferred Population Size: 43.36
 - November 2010 harvested: 39
 - Pond 4
 - March 2010 Population Estimate : 30 CI 16-63
 - Inferred Population Size: 23.60
 - November 2010 harvested: 22
 - Pond 6
 - October 2010 Population Estimate : 52 CI 33-85
 - Inferred Population Size: 42.60
 - November 2010 harvested: 38

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