

Upper Basin Pallid Sturgeon Survival Estimation Project – 2010 Update

Report updated by J. Rotella in fall 2012 using:

1. updated data regarding Fin Curl status of fish in RPMA 1,
2. new data on effort in RPMA 2, and
3. new data on PIT tag retention rates in RPMA 2.

Background

Currently, pallid sturgeon (*Scaphirhynchus albus*) are listed as endangered under the Endangered Species Act. One component of the Recovery Plan for the species is the artificial propagation and release of pallid sturgeon. Each year, tens to hundreds of thousands of juveniles are propagated in captivity and then released in various locations throughout the Upper Basin according to a stocking and augmentation plan (USFWS 2008). These individuals are considered by the USFWS to be members of the listed species. Thus, there is interest in knowing the contribution of hatchery-origin fish to the population. One key step in measuring that contribution is to estimate the probability that a fish reared in captivity and released into the wild will survive to various ages of interest.

Hadley and Rotella (2009) estimated apparent survival for pallid sturgeon on 3 RPMA's using data collected via mark-release-recapture studies of hatchery-reared individuals. The data they used were collected during 1998-2007. Rotella (2010) analyzed updated data that included data from 4 new trapping occasions in each of the RPMA's during 2008-2009. In this addendum to the Hadley and Rotella (2009) and Rotella (2010) reports, results are updated after incorporating data collected through September of 2010 and running the models employed in previous efforts.

Several substantial additions to the previous data analysis efforts are provided here.

- Summary information on numbers of releases and recaptures in each RPMA are provided and are up-to-date through September 2010.
- Estimates of the proportion of each release cohort that was still alive as of late summer 2010 are presented here. These are based on the characteristics of each release cohort and the model used for analyzing data in each RPMA. Estimates are presented by release type and release cohort.
- Estimates of the numbers of fish still alive as of late summer 2010 from each release cohort are presented here. These are also based on the characteristics of each release cohort and the model used for analyzing data in each RPMA. Estimates are presented by release type and release cohort.
- Summaries of the numbers of fish estimated to still be alive in different age categories are also presented in pooled form across release types and release cohorts to indicate the total numbers that were estimated to have been alive in late summer 2010 in each RPMA by age class.
- Computer code was written to conduct all analyses with scripts that allow updating of estimates to be done much more efficiently in the future.

Analysis methods

As was true in the two previous reports, I estimated apparent annual survival (hereafter survival) and capture probabilities and also evaluated the relationships between covariates of interest and survival and capture probabilities for all mark-recapture data sets that were available for pallid sturgeon in Upper Basin RPMAs using Cormack-Jolly-Seber capture-recapture models (Pollock et al. 1990, Lebreton et al.

1992, Williams et al. 2002). All analyses were done using Program MARK (White and Burnham 1999) with the addition that for this report all analyses were done via computer scripts that execute Program MARK through the RMark package (Laake 2010) in the software program R (R Development Core Team 2010). References, more detailed methods, competing model lists, and methods and measures of overdispersion are provided in Hadley and Rotella (2009). Of importance to future analysis, is the fact that the scripts can be edited very quickly and easily to accommodate new sampling occasions and then all models of interest and estimation can be accomplished by re-executing the script. This should allow much more efficient use of resources when future analyses are conducted.

Assumptions of Analysis Approach

1. Every marked animal present in population at sampling period i has same capture probability (p_i) & apparent survival rate (ϕ_i).
 - a. Bias in estimates of ϕ_i from heterogeneity in capture probability is usually negative and small. The models used here incorporated a variety of covariates such as age, RPMA, release type, occasion, season of year and others to model possible sources of heterogeneity.
 - b. Bias in estimates of ϕ_i from heterogeneity in survival probability is usually positive except in the case of transients being in the release sample. Transients are fish that are released and then move to locations that are never subject to sampling or in which they cannot be caught. Transients have apparent survival rates of 0 and cause negative bias in estimates of ϕ_i . The models used here incorporated a variety of covariates such as age, RPMA, release type, occasion, season of year, disease status and others to model possible sources of heterogeneity. However, it is not known to what extent heterogeneity in survival rates might exist due to variation within in age class (e.g., due to differences in size) or due to transient behavior.
2. Marks are not lost, overlooked, or misread. If marks are lost, estimates of ϕ_i are biased downwards. Such bias can be corrected if estimates of tag loss exist. Estimates of tag loss were not available for the analyses presented here. But, if estimates become available, the estimates presented here can be adjusted quite easily.
3. Sampling is instantaneous and animals are released immediately upon capture. If sampling is not instantaneous, then the intervals between sampling occasions are different lengths for different fish, which creates heterogeneity in survival probabilities (because different fish are exposed to mortality for different lengths of time), and, as noted above, the effect of such heterogeneity on bias in apparent survival rates is usually positive. In earlier work, Hadley and Rotella (2009) tried to establish sampling occasions that prevented using excessively long sampling windows while also avoiding eliminating too much recapture data when the start and ending dates of sampling occasions were moved closer together in time. It is not known how much mortality might be occurring during the sampling windows.
4. All emigration is permanent. Temporary emigration causes extreme heterogeneity in capture probability for those individuals that are away from the sampling areas during sampling, i.e., their $p = 0$ on those occasions. If the probability that a fish will be away from the sampling areas is the same for fish that are outside the study area as it is for a fish that is inside the sampling area (i.e., the probability of being temporary emigrant does not depend on the individual's current location),

no bias in survival estimation is expected. Otherwise, temporary emigration can cause negative bias in estimates of ϕ_i .

5. Animal fates with respect to capture and survival are independent. If this is not true, then model-selection procedures tend to choose overly complex models and estimates of precision tend to be too small or overly optimistic. The analyses presented here incorporate the estimates of overdispersion calculated by Hadley and Rotella (2009), which means that model selection and precision estimation were adjusted for estimated lack of independence that might have occurred in the data. It is notable that levels of overdispersion were estimated to be quite modest in these data.

Report Organization

This report is provided as an addendum to Hadley and Rotella (2009) and Rotella (2010). It is not intended to stand-alone. Rather, it is assumed that the reader will be familiar with the earlier reports to be able to take full advantage of the material in this report. This report provides information for one RPMA at a time.

For each RPMA, I first summarize the data that were available on numbers released and recaptured over the course of the study. I then provide estimates for each release type (e.g., fingerlings, spring yearlings, etc) starting with the youngest release type and ending with the oldest. For each release type, I first present estimates based on the earliest cohort (oldest release time) and based on predictions of how that cohort would have done if had had no disease issues. If the cohort itself had no disease issues, then the actual covariate conditions for that cohort were used. If the cohort had fin curl or iridovirus, estimates are generated from the mark-recapture model for a hypothetical healthy cohort based on data from other release cohorts that were healthy but put in the river at a later time. I then provide the estimates of survival rates and surviving numbers of fish for each release cohort based on the actual covariate conditions for each cohort, i.e., their true disease status, river of origin and any other covariates found to be important in the modeling. Finally, I present summaries of the results for all released cohorts of a given release type. I then go on to the results for the next type of release. After results for all release types in a given RPMA are provided, I summarize results by age class across all release types. Finally, I end with summary tables shown together for each RPMA. Throughout the results, I try to emphasize providing the reader with estimated survival rates, surviving proportions, and surviving numbers through time and how those might vary among RPMAs, release types, and release cohorts.

RPMA 1

Dates and numbers for releases and recapture work on RPMA 1.

Occ	Begin	End	Midpoint	Release Numbers for Each Fish Type	
				Spring	Summer
1	08/18/98	08/18/98	08/18/98		1 691
2	09/23/98	10/30/98	10/11/98		
3	04/13/99	04/13/99	04/13/99		
4	08/31/99	09/21/99	09/10/99		
5	09/25/00	09/28/00	09/26/00		
6	09/25/01	10/31/01	10/13/01		
7	07/23/02	07/23/02	07/23/02		2 2,058
8	08/20/02	09/25/02	09/07/02		
9	04/08/03	05/30/03	05/04/03		
10	08/19/03	10/17/03	09/17/03		
11	03/23/04	05/26/04	04/24/04		
12	08/20/04	10/15/04	09/17/04		3 3,113
13	03/29/05	05/25/05	04/26/05	1 521	
14	08/19/05	11/01/05	09/25/05		4 186
15	04/13/06	05/17/06	04/30/06	2 4,751	
16	08/23/06	10/25/06	09/23/06		
17	04/03/07	05/31/07	05/02/07	3 4,537	
18	09/24/07	10/24/07	10/09/07		
19	04/08/08	05/21/08	04/30/08	4 5,686	
20	07/23/08	10/24/08	09/07/08		
21	04/13/09	05/20/09	05/01/09	5 5,127	
22	09/10/09	10/23/09	10/01/09		
23	03/31/10	04/23/10	04/11/10	6 6,096	
24	08/03/10	10/14/10	09/08/10		

Estimates of survival for the 1st release cohort of spring yearlings (~9.5 months old at time of release, which was ~4/26/2005) in RPMA 1. Estimates are for a fish without fin curl. *The estimates here indicate relatively high values for monthly survival rates that vary depending on fish age (survival improves gradually with age) and season of year (lower survival in winter season). Also, they indicate that approximately one third of fish were still alive by the time they reached 7 years of age (previous estimates indicated that nearly all fish were dead shortly after release). Recaptures in recent years have continued to accumulate over multiple release cohorts and provide new first recaptures of a number of new individuals. That recapture information was used here.*

Start Date	End Date	Months	Age at int. start (mos.)	Age at int end (mos.)	Monthly Survival	(SE)	Ppn. Still Alive	(SE)	(95% CI for Cum. Ppn. Surviving)
04/26/05	09/25/05	5.1	9.5	14.6	0.992	(0.011)	0.96	(0.05)	(0.86 to 1.00)
09/25/05	04/30/06	7.2	14.6	21.8	0.950	(0.013)	0.66	(0.08)	(0.51 to 0.81)
04/30/06	09/23/06	4.9	21.8	26.7	0.996	(0.004)	0.65	(0.08)	(0.49 to 0.81)
09/23/06	05/02/07	7.4	26.7	34.0	0.971	(0.008)	0.52	(0.07)	(0.39 to 0.65)
05/02/07	10/09/07	5.3	34.0	39.4	0.997	(0.003)	0.51	(0.07)	(0.38 to 0.64)
10/09/07	04/30/08	6.8	39.4	46.2	0.978	(0.010)	0.44	(0.06)	(0.32 to 0.56)
04/30/08	09/07/08	4.3	46.2	50.5	0.998	(0.002)	0.44	(0.06)	(0.32 to 0.56)
09/07/08	05/01/09	7.9	50.5	58.4	0.985	(0.008)	0.39	(0.07)	(0.26 to 0.52)
05/01/09	10/01/09	5.1	58.4	63.5	0.998	(0.002)	0.39	(0.07)	(0.26 to 0.52)
10/01/09	04/11/10	6.4	63.5	69.9	0.981	(0.015)	0.34	(0.08)	(0.18 to 0.50)
04/11/10	09/08/10	5.0	69.9	74.9	0.999	(0.001)	0.34	(0.08)	(0.18 to 0.50)

¹The monthly survival rate for each month in the interval represented on a given row of the table. The interval-specific survival rate can be calculated by raising the monthly survival rate to the number of months in the interval, e.g., $0.992^{5.1} = 0.96$ (for the 1st interval) or $0.950^{7.2} = 0.69$ (for the 2nd interval). The interval-specific rates can be multiplied together to estimate the proportion still alive after >1 interval of time has passed.

²The proportion of a release cohort still alive, which is calculated based on monthly survival estimates for each interval, the resulting interval-specific estimates of survival, and the product of interval-specific estimates. For example, for the 1st interval, the interval-specific survival rate was $0.992^{5.1} = 0.96$, and for the 2nd interval, the interval-specific survival rate was $0.950^{7.2} = 0.69$. Thus, the proportion still alive at the end of the 1st interval is 0.96 and the proportion still alive at the end of 2nd interval is $0.96 \times 0.69 = 0.66$.

Predictions of survival for the 1st release cohort of spring yearlings (~9.5 months old at time of release, which was ~4/26/2005) in RPMA 1 if fish had fin curl (which this cohort did not). Estimates for fish with fin curl are provided for comparison with rates above only.

Start Date	End Date	Months	Age at int. start (mos.)	Age at int end (mos.)	Monthly Survival	(SE)	Ppn. Still Alive	(SE)	(95% CI for Cum. Ppn. Surviving)
04/26/05	09/25/05	5.1	9.5	14.6	0.988	(0.018)	0.94	(0.08)	(0.77 to 1.00)
09/25/05	04/30/06	7.2	14.6	21.8	0.921	(0.017)	0.52	(0.08)	(0.35 to 0.68)
04/30/06	09/23/06	4.9	21.8	26.7	0.994	(0.007)	0.50	(0.09)	(0.33 to 0.67)
09/23/06	05/02/07	7.4	26.7	34.0	0.953	(0.011)	0.35	(0.05)	(0.25 to 0.46)
05/02/07	10/09/07	5.3	34.0	39.4	0.995	(0.005)	0.34	(0.05)	(0.24 to 0.45)
10/09/07	04/30/08	6.8	39.4	46.2	0.965	(0.016)	0.27	(0.04)	(0.19 to 0.35)
04/30/08	09/07/08	4.3	46.2	50.5	0.997	(0.003)	0.27	(0.04)	(0.18 to 0.35)
09/07/08	05/01/09	7.9	50.5	58.4	0.976	(0.012)	0.22	(0.05)	(0.13 to 0.31)
05/01/09	10/01/09	5.1	58.4	63.5	0.997	(0.003)	0.22	(0.04)	(0.13 to 0.31)
10/01/09	04/11/10	6.4	63.5	69.9	0.970	(0.024)	0.18	(0.06)	(0.06 to 0.29)
04/11/10	09/08/10	5.0	69.9	74.9	0.998	(0.002)	0.18	(0.06)	(0.06 to 0.29)

From these results, it can be seen that monthly survival rates for fish released as spring yearlings are estimated to have relatively high monthly survival rates, and that monthly rates are estimated quite precisely. It can also be seen that the approximately 34% of the original release cohort without fin curl is estimated to remain alive when the fish are ~6 years of age, and the monthly survival rates increase gradually as the fish get older (this can be seen by comparing monthly rates among rows for different years but with similar starting and ending months). If the fish had fin curl, the 2nd table shows that the survival rates are estimated to be lower but still indicates that 6 to 29% (95% CI) of such fish would be alive by ~age 6-years old.

When the number of fish released in a cohort is taken into account, it is possible to estimate the number of fish from each cohort that are estimated to be alive through time. The tables below do this for each release type and cohort using **the average value for disease status in each release cohort**.

Estimates of survival for the 1st release cohort of spring yearlings in RPMA 1 (cohort= 521 fish, average fin curl value in cohort = 0).

Release	Type	Start Date	End Date	Age at int. start (mos.)	Age at int end (mos.)	Ppn. Still Alive	(SE)	N at Interval End	(95% CI for N at Inteval End)		
1	SPR	04/26/05	09/25/05	9.5	14.6	0.96	0.05	501	446	to	521
1	SPR	09/25/05	04/30/06	14.6	21.8	0.66	0.08	345	268	to	422
1	SPR	04/30/06	09/23/06	21.8	26.7	0.65	0.08	339	257	to	420
1	SPR	09/23/06	05/02/07	26.7	34.0	0.52	0.07	272	205	to	340
1	SPR	05/02/07	10/09/07	34.0	39.4	0.51	0.07	268	201	to	336
1	SPR	10/09/07	04/30/08	39.4	46.2	0.44	0.06	231	167	to	294
1	SPR	04/30/08	09/07/08	46.2	50.5	0.44	0.06	229	165	to	292
1	SPR	09/07/08	05/01/09	50.5	58.4	0.39	0.07	204	135	to	272
1	SPR	05/01/09	10/01/09	58.4	63.5	0.39	0.07	202	134	to	270
1	SPR	10/01/09	04/11/10	63.5	69.9	0.34	0.08	179	95	to	263
1	SPR	04/11/10	09/08/10	69.9	74.9	0.34	0.08	178	94	to	261

Estimates of survival for the 2nd release cohort of spring yearlings in RPMA 1 (cohort= 4,751 fish, average fin curl value in cohort = 0.71).

Release	Type	Start Date	End Date	Age at int. start (mos.)	Age at int end (mos.)	Ppn. Still Alive	(SE)	N at Interval End	(95% CI for N at Inteval End)		
2	SPR	04/30/06	09/23/06	9.5	14.4	0.95	0.07	4,505	3,838	to	4,751
2	SPR	09/23/06	05/02/07	14.4	21.7	0.56	0.08	2,668	1,902	to	3,433
2	SPR	05/02/07	10/09/07	21.7	27.1	0.54	0.09	2,581	1,759	to	3,404
2	SPR	10/09/07	04/30/08	27.1	33.9	0.40	0.06	1,922	1,398	to	2,447
2	SPR	04/30/08	09/07/08	33.9	38.2	0.40	0.06	1,893	1,369	to	2,418
2	SPR	09/07/08	05/01/09	38.2	46.1	0.32	0.04	1,536	1,118	to	1,954
2	SPR	05/01/09	10/01/09	46.1	51.2	0.32	0.04	1,515	1,100	to	1,930
2	SPR	10/01/09	04/11/10	51.2	57.6	0.26	0.05	1,230	726	to	1,734
2	SPR	04/11/10	09/08/10	57.6	62.6	0.26	0.05	1,216	722	to	1,711

Estimates of survival for the 3rd release cohort of spring yearlings in RPMA 1 (cohort= 4,537 fish, average fin curl value in cohort = 0).

Release	Type	Start Date	End Date	Age at int. start (mos.)	Age at int end (mos.)	Ppn. Still Alive	(SE)	N at Interval End	(95% CI for N at Inteval End)		
3	SPR	05/02/07	10/09/07	9.5	14.8	0.95	0.06	4,322	3,770	to	4,537
3	SPR	10/09/07	04/30/08	14.8	21.6	0.67	0.07	3,031	2,369	to	3,693
3	SPR	04/30/08	09/07/08	21.6	26.0	0.66	0.08	2,983	2,282	to	3,683
3	SPR	09/07/08	05/01/09	26.0	33.8	0.53	0.07	2,421	1,820	to	3,022
3	SPR	05/01/09	10/01/09	33.8	38.9	0.53	0.07	2,389	1,776	to	3,003
3	SPR	10/01/09	04/11/10	38.9	45.3	0.44	0.06	1,980	1,407	to	2,552
3	SPR	04/11/10	09/08/10	45.3	50.3	0.43	0.06	1,961	1,397	to	2,524

Estimates of survival for the 4th release cohort of spring yearlings in RPMA 1 (cohort= 5,686 fish, average fin curl value in cohort = 0.24).

Release	Type	Start Date	End Date	Age at int. start (mos.)	Age at int end (mos.)	Ppn. Still Alive	(SE)	N at Interval End	(95% CI for N at Inteval End)		
4	SPR	04/30/08	09/07/08	9.5	13.8	0.96	0.05	5,477	4,901	to	5,686
4	SPR	09/07/08	05/01/09	13.8	21.7	0.64	0.09	3,654	2,671	to	4,637
4	SPR	05/01/09	10/01/09	21.7	26.8	0.63	0.1	3,575	2,506	to	4,644
4	SPR	10/01/09	04/11/10	26.8	33.2	0.47	0.06	2,670	1,978	to	3,361
4	SPR	04/11/10	09/08/10	33.2	38.2	0.46	0.06	2,632	1,955	to	3,309

Estimates of survival for the 5th release cohort of spring yearlings in RPMA 1 (cohort= 5,127 fish, average fin curl value in cohort = 0.34).

Release	Type	Start Date	End Date	Age at int. start (mos.)	Age at int end (mos.)	Ppn. Still Alive	(SE)	N at Interval End	(95% CI for N at Inteval End)		
5	SPR	05/01/09	10/01/09	9.5	14.6	0.95	0.06	4,888	4,242	to	5,127
5	SPR	10/01/09	04/11/10	14.6	21.0	0.57	0.08	2,914	2,060	to	3,768
5	SPR	04/11/10	09/08/10	21.0	26.0	0.56	0.08	2,849	2,049	to	3,650

Summary information for spring yearlings released in RPMA 1.

When the most recent estimates of the proportion surviving and the number surviving from each release cohort are assembled, one can review how many fish released as spring yearlings are estimated to still be alive. At the time of the last estimation date (09/08/2010), ~8,836 fish released as spring yearlings were estimated to have been still alive in the river. Of these ~62% (5,481) were \leq 3 years old, and ~178 were older than 6 years old.

Estimates of surviving proportions and numbers for spring yearling releases in RPMA 1.

Release	Type	Date	Age in months	Age in years	Ppn. Still Alive	(SE)	N Alive	(95% CI for N Alive)		
1: 521	SPR	09/08/10	74.9	6.2	0.34	0.08	178	94	to	261
2: 4,751	SPR	09/08/10	62.6	5.2	0.26	0.05	1,216	722	to	1,711
3: 4,537	SPR	09/08/10	50.3	4.2	0.43	0.06	1,961	1,397	to	2,524
4: 5,686	SPR	09/08/10	38.2	3.2	0.46	0.06	2,632	1,955	to	3,309
5: 5,127	SPR	09/08/10	26.0	2.2	0.56	0.08	2,849	2,049	to	3,650

Results for Releases of Summer Yearlings in RPMA 1

Data on the number of summer yearlings released on each occasion ($R(i)$) along with information on when they were 1st subsequently recaptured (on occasion j) is provided in the table below. At the time of the analyses presented here, 6,320 releases and re-releases of fish originally released as summer yearlings had been conducted, which resulted in 278 recaptures. The results presented below are based on the analyses of those 278 recaptures from 6,320 releases and re-releases.

Occ. ²	R(i)	j=	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Total
1	691	3	1	2	3	5	0	8	11	6	31	9	19	5	8	8	13	11	10	7	7	5	8	2	182	
2	3		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	
3	1			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
4	2				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
5	3					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
6	5						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
7	2058							5	0	3	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	
8	13								0	2	0	0	0	0	0	0	0	0	0	1	0	0	0	0	3	
9	11									0	1	0	0	0	0	0	0	0	1	0	1	0	1	0	4	
10	9										0	0	0	0	0	1	0	0	1	0	0	1	0	0	3	
11	34											1	0	1	1	1	2	0	1	0	0	0	0	0	7	
12	3123												11	1	0	0	1	1	0	2	0	1	1	1	18	
13	30													0	2	1	0	2	0	0	1	0	1	0	7	
14	193														1	1	2	0	2	0	1	2	0	0	9	
15	12															0	0	1	2	0	0	1	0	0	4	
16	13																0	0	2	1	0	0	1	0	4	
17	18																	1	4	0	0	1	2	1	9	
18	18																		1	1	1	1	1	0	5	
19	23																			0	0	0	4	1	5	
20	12																				1	0	0	0	1	
21	12																					0	1	1	2	
22	13																						4	0	4	
23	23																							1	1	

Estimates of survival for the 1st release cohort of summer yearlings (~14.2 months old at time of release, which was ~8/18/1998) in RPMA 1. Estimates are for a fish without fin curl. *The estimates presented here are slightly lower than what was presented in the most recent report (Rotella 2010) but still indicate that substantial proportions of healthy releases of summer yearlings remain alive long after release. As before, the estimation indicates that survival is very high once fish are several years old.*

Start Date	End Date	Months	Age at int. start (mos.)	Age at int end (mos.)	Monthly Survival	(SE)	Ppn. Still Alive	(SE)	(95% CI for Cum. Ppn. Surviving)	
08/18/98	10/11/98	1.8	14.2	16.0	0.991	(0.009)	0.98	(0.02)	(0.95	to 1.00)
10/11/98	04/13/99	6.1	16.0	22.2	0.946	(0.016)	0.70	(0.07)	(0.56	to 0.83)
04/13/99	09/10/99	5.0	22.2	27.2	0.997	(0.004)	0.69	(0.06)	(0.57	to 0.81)
09/10/99	09/26/00	12.7	27.2	39.9	0.990	(0.004)	0.61	(0.06)	(0.49	to 0.72)
09/26/00	10/13/01	12.7	39.9	52.6	0.993	(0.002)	0.55	(0.06)	(0.44	to 0.66)
10/13/01	07/23/02	9.4	52.6	62.1	0.993	(0.002)	0.51	(0.06)	(0.41	to 0.62)
07/23/02	09/07/02	1.5	62.0	63.6	0.999	(0.001)	0.51	(0.06)	(0.40	to 0.62)
09/07/02	05/04/03	8.0	63.6	71.5	0.991	(0.003)	0.48	(0.05)	(0.38	to 0.57)
05/04/03	09/17/03	4.5	71.5	76.1	0.999	(0.001)	0.47	(0.05)	(0.38	to 0.57)
09/17/03	04/24/04	7.3	76.1	83.4	0.991	(0.005)	0.44	(0.05)	(0.35	to 0.53)
04/24/04	09/17/04	4.9	83.4	88.3	0.999	(0.001)	0.44	(0.05)	(0.35	to 0.53)
09/17/04	04/26/05	7.4	88.3	95.7	0.992	(0.004)	0.41	(0.05)	(0.32	to 0.51)
04/26/05	09/25/05	5.1	95.7	100.7	0.999	(0.001)	0.41	(0.05)	(0.32	to 0.51)
09/25/05	04/30/06	7.2	100.7	108.0	0.993	(0.004)	0.39	(0.05)	(0.29	to 0.49)
04/30/06	09/23/06	4.9	108.0	112.8	0.999	(0.001)	0.39	(0.05)	(0.29	to 0.49)
09/23/06	05/02/07	7.4	112.8	120.2	0.994	(0.004)	0.37	(0.06)	(0.26	to 0.48)
05/02/07	10/09/07	5.3	120.2	125.5	0.999	(0.001)	0.37	(0.05)	(0.26	to 0.48)
10/09/07	04/30/08	6.8	125.5	132.3	0.994	(0.004)	0.36	(0.06)	(0.24	to 0.47)
04/30/08	09/07/08	4.3	132.3	136.7	0.999	(0.001)	0.36	(0.06)	(0.24	to 0.47)
09/07/08	05/01/09	7.9	136.7	144.5	0.995	(0.003)	0.34	(0.06)	(0.22	to 0.47)
05/01/09	10/01/09	5.1	144.5	149.6	0.999	(0.001)	0.34	(0.06)	(0.22	to 0.47)
10/01/09	04/11/10	6.4	149.6	156.0	0.993	(0.006)	0.33	(0.07)	(0.19	to 0.47)
04/11/10	09/08/10	5.0	156.0	161.0	1.000	(0.000)	0.33	(0.07)	(0.19	to 0.46)

Predictions of survival for the 1st release cohort of summer yearlings (~14.2 months old at time of release, which was ~8/18/1998) in RPMA 1 if fish had fin curl (which this cohort did not). Estimates for fish with fin curl are provided for comparison with rates above only. Here, the estimates indicate a stronger effect of fin curl than what was seen in spring yearlings in RPMA 1 such that none of the release cohort is expected to be alive by ~age 6-to-7 years of age. *As in the previous report, very few fish with fin curl are estimated to be alive several years after release.*

Start Date	End Date	Months	Age at int. start (mos.)	Age at int end (mos.)	Monthly Survival	(SE)	Ppn. Still Alive	(SE)	(95% CI for Cum. Ppn. Surviving)		
08/18/98	10/11/98	1.8	14.2	16.0	0.936	(0.062)	0.89	(0.11)	(0.68	to	1.00)
10/11/98	04/13/99	6.1	16.0	22.2	0.691	(0.046)	0.09	(0.03)	(0.03	to	0.15)
04/13/99	09/10/99	5.0	22.2	27.2	0.975	(0.030)	0.08	(0.02)	(0.04	to	0.13)
09/10/99	09/26/00	12.7	27.2	39.9	0.928	(0.030)	0.03	(0.01)	(0.00	to	0.06)
09/26/00	10/13/01	12.7	39.9	52.6	0.945	(0.019)	0.02	(0.01)	(0.00	to	0.04)
10/13/01	07/23/02	9.4	52.6	62.1	0.947	(0.015)	0.01	(0.01)	(0.00	to	0.02)
07/23/02	09/07/02	1.5	62.0	63.6	0.991	(0.010)	0.01	(0.01)	(0.00	to	0.02)
09/07/02	05/04/03	8.0	63.6	71.5	0.931	(0.025)	0.01	(0.00)	(0.00	to	0.01)
05/04/03	09/17/03	4.5	71.5	76.1	0.992	(0.008)	0.00	(0.00)	(0.00	to	0.01)
09/17/03	04/24/04	7.3	76.1	83.4	0.932	(0.033)	0.00	(0.00)	(0.00	to	0.01)
04/24/04	09/17/04	4.9	83.4	88.3	0.993	(0.007)	0.00	(0.00)	(0.00	to	0.01)
09/17/04	04/26/05	7.4	88.3	95.7	0.940	(0.032)	0.00	(0.00)	(0.00	to	0.00)
04/26/05	09/25/05	5.1	95.7	100.7	0.994	(0.006)	0.00	(0.00)	(0.00	to	0.00)
09/25/05	04/30/06	7.2	100.7	108.0	0.946	(0.032)	0.00	(0.00)	(0.00	to	0.00)
04/30/06	09/23/06	4.9	108.0	112.8	0.995	(0.006)	0.00	(0.00)	(0.00	to	0.00)
09/23/06	05/02/07	7.4	112.8	120.2	0.952	(0.030)	0.00	(0.00)	(0.00	to	0.00)
05/02/07	10/09/07	5.3	120.2	125.5	0.994	(0.005)	0.00	(0.00)	(0.00	to	0.00)
10/09/07	04/30/08	6.8	125.5	132.3	0.955	(0.031)	0.00	(0.00)	(0.00	to	0.00)
04/30/08	09/07/08	4.3	132.3	136.7	0.996	(0.004)	0.00	(0.00)	(0.00	to	0.00)
09/07/08	05/01/09	7.9	136.7	144.5	0.965	(0.023)	0.00	(0.00)	(0.00	to	0.00)
05/01/09	10/01/09	5.1	144.5	149.6	0.996	(0.004)	0.00	(0.00)	(0.00	to	0.00)
10/01/09	04/11/10	6.4	149.6	156.0	0.950	(0.042)	0.00	(0.00)	(0.00	to	0.00)
04/11/10	09/08/10	5.0	156.0	161.0	0.996	(0.004)	0.00	(0.00)	(0.00	to	0.00)

From these results, it can be seen that monthly survival rates for fish released as summer yearlings without fin curl are estimated to have relatively high monthly survival rates, and that monthly rates are estimated quite precisely. It can also be seen that approximately 47% of the original release cohort is estimated to remain alive when the fish are ~6 years of age, and the monthly survival rates increase gradually as the fish get older. If the fish had fin curl, the 2nd table shows that the survival rates are estimated to be lower and that all fish are expected to be dead by ~ age 6-7 years of age.

When the number of fish released in a cohort is taken into account, it is possible to estimate the number of fish from each cohort that are estimated to be alive through time. The tables below do this for each release type and cohort using **the average value for disease status in each release cohort.**

Estimates of survival for the 1st release cohort of summer yearlings in RPMA 1 (cohort= 691 fish, average fin curl value in cohort = 0). *Previous reports of survival analyses did not provide such information and so such information is new for these analyses. Accordingly, comparisons with previous results cannot be made and will not appear for any RPMA.*

Release	Type	Start Date	End Date	Age at int. start (mos.)	Age at int end (mos.)	Ppn. Still Alive	(SE)	N at Interval End	(95% CI for N at Inteval End)		
1	SUM	08/18/98	10/11/98	14.2	16.0	0.98	0.02	680	659	to	691
1	SUM	10/11/98	04/13/99	16.0	22.2	0.70	0.07	483	390	to	575
1	SUM	04/13/99	09/10/99	22.2	27.2	0.69	0.06	475	391	to	558
1	SUM	09/10/99	09/26/00	27.2	39.9	0.61	0.06	418	340	to	497
1	SUM	09/26/00	10/13/01	39.9	52.6	0.55	0.06	381	302	to	459
1	SUM	10/13/01	07/23/02	52.6	62.1	0.51	0.06	356	281	to	431
1	SUM	07/23/02	09/07/02	62.0	63.6	0.51	0.06	355	280	to	430
1	SUM	09/07/02	05/04/03	63.6	71.5	0.48	0.05	329	262	to	396
1	SUM	05/04/03	09/17/03	71.5	76.1	0.47	0.05	328	260	to	395
1	SUM	09/17/03	04/24/04	76.1	83.4	0.44	0.05	306	243	to	369
1	SUM	04/24/04	09/17/04	83.4	88.3	0.44	0.05	304	241	to	368
1	SUM	09/17/04	04/26/05	88.3	95.7	0.41	0.05	287	222	to	351
1	SUM	04/26/05	09/25/05	95.7	100.7	0.41	0.05	286	221	to	350
1	SUM	09/25/05	04/30/06	100.7	108.0	0.39	0.05	271	202	to	340
1	SUM	04/30/06	09/23/06	108.0	112.8	0.39	0.05	270	201	to	338
1	SUM	09/23/06	05/02/07	112.8	120.2	0.37	0.06	257	183	to	332
1	SUM	05/02/07	10/09/07	120.2	125.5	0.37	0.05	256	182	to	331
1	SUM	10/09/07	04/30/08	125.5	132.3	0.36	0.06	246	165	to	327
1	SUM	04/30/08	09/07/08	132.3	136.7	0.36	0.06	245	165	to	326
1	SUM	09/07/08	05/01/09	136.7	144.5	0.34	0.06	237	150	to	323
1	SUM	05/01/09	10/01/09	144.5	149.6	0.34	0.06	236	150	to	322
1	SUM	10/01/09	04/11/10	149.6	156.0	0.33	0.07	226	130	to	322
1	SUM	04/11/10	09/08/10	156.0	161.0	0.33	0.07	226	130	to	321

Estimates of survival for the 2nd release cohort of summer yearlings in RPMA 1 (cohort= 2,058 fish, average fin curl value in cohort = 1).

Release	Type	Start Date	End Date	Age at int. start (mos.)	Age at int end (mos.)	Ppn. Still Alive	(SE)	N at Interval End	(95% CI for N at Inteval End)		
2	SUM	07/23/02	09/07/02	14.2	15.8	0.94	0.07	1,940	1,642	to	2,058
2	SUM	09/07/02	05/04/03	15.8	23.7	0.12	0.04	249	76	to	422
2	SUM	05/04/03	09/17/03	23.7	28.3	0.11	0.05	224	24	to	424
2	SUM	09/17/03	04/24/04	28.3	35.6	0.03	0.01	61	16	to	105
2	SUM	04/24/04	09/17/04	35.6	40.5	0.03	0.01	56	9	to	104
2	SUM	09/17/04	04/26/05	40.5	47.8	0.01	0.00	22	5	to	39
2	SUM	04/26/05	09/25/05	47.8	52.9	0.01	0.00	21	4	to	38
2	SUM	09/25/05	04/30/06	52.9	60.1	0.00	0.00	10	0	to	19
2	SUM	04/30/06	09/23/06	60.1	65.0	0.00	0.00	9	0	to	19
2	SUM	09/23/06	05/02/07	65.0	72.4	0.00	0.00	5	0	to	12
2	SUM	05/02/07	10/09/07	72.4	77.7	0.00	0.00	5	0	to	11
2	SUM	10/09/07	04/30/08	77.7	84.5	0.00	0.00	3	0	to	8
2	SUM	04/30/08	09/07/08	84.5	88.8	0.00	0.00	3	0	to	8
2	SUM	09/07/08	05/01/09	88.8	96.7	0.00	0.00	2	0	to	6
2	SUM	05/01/09	10/01/09	96.7	101.8	0.00	0.00	2	0	to	6
2	SUM	10/01/09	04/11/10	101.8	108.2	0.00	0.00	1	0	to	4
2	SUM	04/11/10	09/08/10	108.2	113.2	0.00	0.00	1	0	to	4

Estimates of survival for the 3rd release cohort of summer yearlings in RPMA 1 (cohort= 3,113 fish, average fin curl value in cohort = 1).

Release	Type	Start Date	End Date	Age at int. start (mos.)	Age at int end (mos.)	Ppn. Still Alive	(SE)	N at Interval End	(95% CI for N at Inteval End)		
3	SUM	09/17/04	04/26/05	14.2	21.6	0.09	0.03	286	97	to	474
3	SUM	04/26/05	09/25/05	21.6	26.7	0.08	0.03	251	58	to	444
3	SUM	09/25/05	04/30/06	26.7	33.9	0.02	0.01	62	17	to	108
3	SUM	04/30/06	09/23/06	33.9	38.8	0.02	0.01	58	13	to	102
3	SUM	09/23/06	05/02/07	38.8	46.1	0.01	0.00	22	5	to	38
3	SUM	05/02/07	10/09/07	46.1	51.5	0.01	0.00	20	4	to	36
3	SUM	10/09/07	04/30/08	51.5	58.3	0.00	0.00	10	0	to	19
3	SUM	04/30/08	09/07/08	58.3	62.6	0.00	0.00	9	0	to	18
3	SUM	09/07/08	05/01/09	62.6	70.5	0.00	0.00	5	0	to	12
3	SUM	05/01/09	10/01/09	70.5	75.6	0.00	0.00	5	0	to	11
3	SUM	10/01/09	04/11/10	75.6	82.0	0.00	0.00	3	0	to	8
3	SUM	04/11/10	09/08/10	82.0	87.0	0.00	0.00	3	0	to	7

Estimates of survival for the 4th release cohort of summer yearlings in RPMA 1 (cohort= 186 fish, average fin curl value in cohort = 0.005).

Release	Type	Start Date	End Date	Age at int. start (mos.)	Age at int end (mos.)	Ppn. Still Alive	(SE)	N at Interval End	(95% CI for N at Inteval End)		
4	SUM	09/25/05	04/30/06	14.2	21.5	0.70	0.06	130	106	to	153
4	SUM	04/30/06	09/23/06	21.5	26.3	0.69	0.06	128	104	to	151
4	SUM	09/23/06	05/02/07	26.3	33.7	0.56	0.07	105	81	to	129
4	SUM	05/02/07	10/09/07	33.7	39.0	0.56	0.06	103	80	to	126
4	SUM	10/09/07	04/30/08	39.0	45.8	0.49	0.06	91	68	to	113
4	SUM	04/30/08	09/07/08	45.8	50.2	0.48	0.06	90	68	to	112
4	SUM	09/07/08	05/01/09	50.2	58.0	0.44	0.06	81	60	to	103
4	SUM	05/01/09	10/01/09	58.0	63.1	0.44	0.06	81	60	to	102
4	SUM	10/01/09	04/11/10	63.1	69.5	0.39	0.06	73	50	to	97
4	SUM	04/11/10	09/08/10	69.5	74.5	0.39	0.06	73	50	to	96

Summary information for summer yearlings released in RPMA 1.

When the most recent estimates of the proportion surviving and the number surviving from each release cohort are assembled, one can review how many fish released as summer yearlings are estimated to still have been alive at the end of the time considered here. There are estimated to be ~303 fish released as summer yearlings alive in the river at the time of the last estimation date (09/08/2010). All of these were older than 6 years old, and ~75% were >13 years old.

Estimates of surviving proportions and numbers for summer yearling releases in RPMA 1.

Release	Type	Date	Age in months	Age in years	Ppn. Still Alive	(SE)	N Alive	(95% CI for N Alive)		
1: 691	SUM	09/08/10	161.0	13.4	0.33	0.07	226	130	to	321
2: 2,058	SUM	09/08/10	113.2	9.4	0.00	0.00	1	0	to	4
3: 3,113	SUM	09/08/10	87.0	7.3	0.00	0.00	3	0	to	7
4: 186	SUM	09/08/10	74.5	6.2	0.39	0.06	73	50	to	96

Summary of number alive as of 09/08/2010 across all releases of fish in RPMA 1.

The previous reports did not provide such information and so such information is new for these analyses. Accordingly, comparisons with previous results cannot be made and will not appear for any RPMA.

Release*	Type	Date	Age in months	Age in years	Ppn. Still Alive	(SE)	N Alive	(95% CI for N Alive)		
5: 5,127	SPR	09/08/10	26.0	2.2	0.56	0.08	2,849	2,049	to	3,650
4: 5,686	SPR	09/08/10	38.2	3.2	0.46	0.06	2,632	1,955	to	3,309
3: 4,537	SPR	09/08/10	50.3	4.2	0.43	0.06	1,961	1,397	to	2,524
2: 4,751	SPR	09/08/10	62.6	5.2	0.26	0.05	1,216	722	to	1,711
4: 186	SUM	09/08/10	74.5	6.2	0.39	0.06	73	50	to	96
1: 521	SPR	09/08/10	74.9	6.2	0.34	0.08	178	94	to	261
3: 3,113	SUM	09/08/10	87.0	7.3	0.00	0.00	3	0	to	7
2: 2,058	SUM	09/08/10	113.2	9.4	0.00	0.00	1	0	to	4
1: 691	SUM	09/08/10	161.0	13.4	0.33	0.07	226	130	to	321

**The Release column represents (a) the release cohort for the specific type of release and (b) the number of individuals in that release cohort.*

When summarized by age class, the estimates indicate that ~9,139 of the fish that were released from hatcheries in recent years in RPMA 1 were still alive there in September of 2010. Of these fish, ~31% (or 2,849 fish) were estimated to be ~2-years old, ~64% (or 5,809) were ~3- to 5-years old, ~3% (or 255) were ~6- to 9-years old, and ~2% (or 226) were >13-years old.

1	09/08/10	1 to 2	2,849	2,049	to	3,650
1	09/08/10	3 to 5	5,809	4,074	to	7,544
1	09/08/10	6 to 9	255	144	to	368
1	09/08/10	>11	226	130	to	321

RPMA 2

Dates and numbers for releases and recapture work on RPMA 2.

Occ	Begin	End	Midpoint	Release Numbers for Each Fish Type		
				Fingerlings	Spring	Summer
1	08/11/98	08/11/98	08/11/98			1 789
2	10/11/00	10/17/00	10/14/00			2 478
3	07/18/02	09/18/02	08/18/02			3 3,089
4	08/07/03	08/28/03	08/17/03			4 4,010
5	04/13/04	04/13/04	04/13/04		1 821	
6	08/16/04	10/21/04	09/21/04	1 16,810		5 1,586
7	04/12/05	05/18/05	04/30/05		2 870	
8	08/15/05	11/02/05	09/23/05	2 12,469		6 175
9	03/28/06	05/31/06	04/29/06		3 6,671	
10	07/13/06	07/13/06	07/13/06			7 1,363
11	08/14/06	11/08/06	09/27/06	3 6,916		
12	04/03/07	05/31/07	05/02/07		4 3,951	
13	08/14/07	10/31/07	09/22/07	4 41,469		
14	03/26/08	06/04/08	04/30/08		5 8,005	
15	07/17/08	07/30/08	07/22/08			8 3,260
16	08/04/08	10/29/08	09/16/08	5 58,838		
17	04/13/09	06/03/09	05/08/09		6 4,882	
18	07/22/09	07/22/09	07/22/09			9 3,780
19	08/03/09	10/28/09	09/15/09	6 40,948		
20	04/05/10	06/02/10	05/04/10		7 10,429	
21	07/28/10	10/21/10	09/08/10	7 4,000		10 1,886

For RPMA 2, the top model of the mark-recapture data included the following covariates of survival: release type, age of fish, release site (Missouri vs Yellowstone River), iridovirus status for fish released as fingerlings, and fin curl status at release. The model of capture probability included release type, fish age, season of year (spring versus fall), river of release (Missouri vs Yellowstone River), and capture effort expended during a given trapping occasion.

To depict survival patterns estimated from the data for each type of release, the earliest release of a given type (e.g., fingerlings at release) is used. In this way, the greatest amount of time from release to present is used, and in this way the cumulative proportion of fish remaining alive in the river is presented for the greatest extent of time possible with the data. Results for other releases are similar but do not extend as far forward in time or in terms of fish age.

Results for Releases of Fingerlings in RPMA 2

Data on the number of fingerlings released on each occasion ($R(i)$) along with information on when they were 1st subsequently recaptured (on occasion j) is provided in the table below. At the time of the analyses presented here, 177,883 releases and re-releases of fish originally released as fingerlings had been conducted, which resulted in 858 recaptures. The results presented below are based on the analyses of those 858 recaptures from 177,883 releases and re-releases.

Fingerlings

occ.	$R(i)$	$j=$	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	Total
1	0		0																				0
2	0			0																			0
3	0				0																		0
4	0					0																	0
5	0						0																0
6	16810							0															0
7	0								0														0
8	12469									0													0
9	1										0												0
10	0											0											0
11	6928												0										0
12	4													0									0
13	41552														0								0
14	24															0							0
15	0																0						0
16	58912																	0					0
17	26																		0				0
18	0																			0			0
19	41120																				0		0
20	37																					3	167
																							1
																							1

Estimates of survival for the 1st release cohort of fingerlings (~2.7 months old at time of release, which was ~9/21/2004) in RPMA 2. Estimates are for a fish without disease problems (no fin curl or iridovirus) and averaged evenly across results for releases in Missouri and Yellowstone Rivers. As such these are idealize rather than real fish. *The current estimates show a more smooth improvement in survival rate with age, whereas previous estimates indicated that survival was modest early in life and then estimated no mortality after the 1st year, which did not seem particularly realistic. The estimate of survival over the 1st year in the river is very similar here to what was previously estimated. It is notable that increases in numbers of captures of fish released as yearlings have been made in the most recent years, which were incorporated here.*

Start Date	End Date	Months	Age at int.	Age at int.	Monthly Survival	(SE)	Ppn.		(95% CI for Cum. Ppn. Surviving)
			start (mos.)	end (mos.)			Still Alive	(SE)	
09/21/04	04/30/05	7.4	2.7	10.1	0.968	(0.006)	0.79	(0.04)	(0.71 to 0.86)
04/30/05	09/23/05	4.9	10.1	14.9	0.973	(0.005)	0.69	(0.05)	(0.59 to 0.79)
09/23/05	04/29/06	7.3	14.9	22.2	0.975	(0.004)	0.57	(0.06)	(0.46 to 0.69)
04/29/06	07/13/06	2.5	22.2	24.7	0.979	(0.004)	0.54	(0.06)	(0.43 to 0.66)
07/13/06	09/27/06	2.5	24.7	27.2	0.980	(0.003)	0.52	(0.06)	(0.40 to 0.64)
09/27/06	05/02/07	7.2	27.2	34.5	0.981	(0.003)	0.45	(0.06)	(0.33 to 0.58)
05/02/07	09/22/07	4.8	34.5	39.2	0.984	(0.003)	0.42	(0.06)	(0.29 to 0.54)
09/22/07	04/30/08	7.4	39.2	46.6	0.986	(0.003)	0.38	(0.06)	(0.25 to 0.50)
04/30/08	07/22/08	2.8	46.6	49.4	0.988	(0.003)	0.36	(0.06)	(0.24 to 0.49)
07/22/08	09/16/08	1.9	49.4	51.2	0.989	(0.003)	0.36	(0.06)	(0.23 to 0.48)
09/16/08	05/08/09	7.8	51.2	59.0	0.989	(0.003)	0.33	(0.06)	(0.20 to 0.45)
05/08/09	07/22/09	2.5	59.0	61.5	0.991	(0.002)	0.32	(0.06)	(0.20 to 0.44)
07/22/09	09/15/09	1.8	61.5	63.4	0.991	(0.002)	0.31	(0.06)	(0.19 to 0.44)
09/15/09	05/04/10	7.7	63.4	71.1	0.992	(0.002)	0.29	(0.06)	(0.17 to 0.42)
05/04/10	09/08/10	4.2	71.1	75.3	0.993	(0.002)	0.29	(0.06)	(0.16 to 0.41)

From these results, it can be seen that monthly survival rates for fish released as fingerlings are estimated to have relatively high monthly survival rates, and that monthly rates are estimated quite precisely. It can also be seen that the approximately 29% of the original release cohort is estimated to remain alive when the fish are ~6 years of age. The loss of fish drops off at a fairly slow rate beyond 5 years of age.

When the number of fish released in a cohort is taken into account, it is possible to estimate the number of fish from each cohort that are estimated to be alive through time. The tables below do this for each release type and cohort using **the average value for river of releases and for disease status in each release cohort**. Thus, these represent estimates based on the average covariate conditions experienced by a release cohort rather than an idealized cohort without disease that is averaged across releases on the Missouri and the Yellowstone Rivers, which is what was done in the table immediately above.

The previous reports did not provide such information and so such information is new for these analyses. Accordingly, comparisons with previous results cannot be made and will not appear for any RPMA.

Estimates of survival for the 1st release cohort of fingerlings in RPMA 2 (cohort= 16,810 fish, 67% released in Missouri, IV status = 1, Fin Curl status = 0). *Poor survival rates of fish with iridovirus status of 1 are readily apparent when these results are compared with those for release cohorts with iridovirus status of 0 (see next 3 tables for comparisons).*

Release	Type	Start Date	End Date	Age at int. start (mos.)	Age at int end (mos.)	Ppn. Still Alive	(SE)	N at Interval End	(95% CI for N at Inteval End)		
1	FNG	09/21/04	04/30/05	2.7	10.1	0.32	0.06	5,309	3,365	to	7,254
1	FNG	04/30/05	09/23/05	10.1	14.9	0.16	0.05	2,764	1,246	to	4,281
1	FNG	09/23/05	04/29/06	14.9	22.2	0.07	0.03	1,147	254	to	2,040
1	FNG	04/29/06	07/13/06	22.2	24.7	0.05	0.02	885	142	to	1,628
1	FNG	07/13/06	09/27/06	24.7	27.2	0.04	0.02	690	71	to	1,309
1	FNG	09/27/06	05/02/07	27.2	34.5	0.02	0.01	352	0	to	723
1	FNG	05/02/07	09/22/07	34.5	39.2	0.01	0.01	241	0	to	515
1	FNG	09/22/07	04/30/08	39.2	46.6	0.01	0.01	142	0	to	321
1	FNG	04/30/08	07/22/08	46.6	49.4	0.01	0.00	120	0	to	276
1	FNG	07/22/08	09/16/08	49.4	51.2	0.01	0.00	107	0	to	250
1	FNG	09/16/08	05/08/09	51.2	59.0	0.00	0.00	70	0	to	171
1	FNG	05/08/09	07/22/09	59.0	61.5	0.00	0.00	62	0	to	154
1	FNG	07/22/09	09/15/09	61.5	63.4	0.00	0.00	57	0	to	143
1	FNG	09/15/09	05/04/10	63.4	71.1	0.00	0.00	41	0	to	108
1	FNG	05/04/10	09/08/10	71.1	75.3	0.00	0.00	35	0	to	95

Estimates of survival for the 2nd release cohort of fingerlings in RPMA 2 (cohort= 12,469 fish, 68% released in Missouri, IV status = 0, Fin Curl status = 0.13).

Release	Type	Start Date	End Date	Age at int. start (mos.)	Age at int end (mos.)	Ppn. Still Alive	(SE)	N at Interval End	(95% CI for N at Inteval End)		
2	FNG	09/23/05	04/29/06	2.7	9.9	0.76	0.04	9,428	8,405	to	10,450
2	FNG	04/29/06	07/13/06	9.9	12.4	0.70	0.05	8,686	7,495	to	9,878
2	FNG	07/13/06	09/27/06	12.4	15.0	0.64	0.05	8,031	6,715	to	9,347
2	FNG	09/27/06	05/02/07	15.0	22.2	0.52	0.06	6,497	4,974	to	8,020
2	FNG	05/02/07	09/22/07	22.2	27.0	0.46	0.06	5,767	4,201	to	7,333
2	FNG	09/22/07	04/30/08	27.0	34.4	0.39	0.06	4,887	3,314	to	6,460
2	FNG	04/30/08	07/22/08	34.4	37.1	0.37	0.06	4,635	3,071	to	6,200
2	FNG	07/22/08	09/16/08	37.1	39.0	0.36	0.06	4,482	2,925	to	6,040
2	FNG	09/16/08	05/08/09	39.0	46.8	0.31	0.06	3,919	2,398	to	5,441
2	FNG	05/08/09	07/22/09	46.8	49.3	0.30	0.06	3,780	2,271	to	5,289
2	FNG	07/22/09	09/15/09	49.3	51.1	0.30	0.06	3,687	2,186	to	5,188
2	FNG	09/15/09	05/04/10	51.1	58.8	0.27	0.06	3,332	1,865	to	4,799
2	FNG	05/04/10	09/08/10	58.8	63.0	0.26	0.06	3,180	1,728	to	4,632

Estimates of survival for the 3rd release cohort of fingerlings in RPMA 2 (cohort= 6,916 fish, 67% released in Missouri, IV status = 0, Fin Curl status = 0).

Release	Type	Start Date	End Date	Age at int. start (mos.)	Age at int end (mos.)	Ppn. Still Alive	(SE)	N at Interval End	(95% CI for N at Inteval End)		
3	FNG	09/27/06	05/02/07	2.7	9.9	0.78	0.04	5,422	4,904	to	5,941
3	FNG	05/02/07	09/22/07	9.9	14.7	0.68	0.05	4,729	4,047	to	5,411
3	FNG	09/22/07	04/30/08	14.7	22.1	0.57	0.06	3,910	3,095	to	4,725
3	FNG	04/30/08	07/22/08	22.1	24.8	0.53	0.06	3,680	2,843	to	4,516
3	FNG	07/22/08	09/16/08	24.8	26.7	0.51	0.06	3,540	2,694	to	4,387
3	FNG	09/16/08	05/08/09	26.7	34.5	0.44	0.06	3,035	2,165	to	3,904
3	FNG	05/08/09	07/22/09	34.5	37.0	0.42	0.06	2,911	2,041	to	3,781
3	FNG	07/22/09	09/15/09	37.0	38.8	0.41	0.06	2,828	1,959	to	3,698
3	FNG	09/15/09	05/04/10	38.8	46.5	0.36	0.06	2,518	1,656	to	3,381
3	FNG	05/04/10	09/08/10	46.5	50.8	0.35	0.06	2,386	1,529	to	3,243

Estimates of survival for the 4th release cohort of fingerlings in RPMA 2 (cohort= 41,469 fish, 49% released in Missouri, IV status = 0, Fin Curl status = 0).

Release	Type	Start Date	End Date	Age at int. start (mos.)	Age at int end (mos.)	Ppn. Still Alive	(SE)	N at Interval End	(95% CI for N at Inteval End)		
4	FNG	09/22/07	04/30/08	2.7	10.1	0.79	0.04	32,706	29,665	to	35,746
4	FNG	04/30/08	07/22/08	10.1	12.8	0.73	0.04	30,318	26,687	to	33,949
4	FNG	07/22/08	09/16/08	12.8	14.7	0.70	0.05	28,893	24,958	to	32,829
4	FNG	09/16/08	05/08/09	14.7	22.5	0.57	0.06	23,831	19,036	to	28,626
4	FNG	05/08/09	07/22/09	22.5	25.0	0.55	0.06	22,625	17,708	to	27,542
4	FNG	07/22/09	09/15/09	25.0	26.8	0.53	0.06	21,826	16,843	to	26,809
4	FNG	09/15/09	05/04/10	26.8	34.5	0.46	0.06	18,875	13,723	to	24,028
4	FNG	05/04/10	09/08/10	34.5	38.8	0.43	0.06	17,648	12,476	to	22,820

Estimates of survival for the 5th release cohort of fingerlings in RPMA 2 (cohort= 58,838 fish, 46% released in Missouri, IV status = 0, Fin Curl status = 0.14).

Release	Type	Start Date	End Date	Age at int. start (mos.)	Age at int end (mos.)	Ppn. Still Alive	(SE)	N at Interval End	(95% CI for N at Inteval End)	
5	FNG	09/16/08	05/08/09	2.7	10.5	0.75	0.04	44,117	39,211	to 49,022
5	FNG	05/08/09	07/22/09	10.5	13.0	0.69	0.05	40,819	35,181	to 46,456
5	FNG	07/22/09	09/15/09	13.0	14.8	0.66	0.05	38,680	32,638	to 44,722
5	FNG	09/15/09	05/04/10	14.8	22.5	0.53	0.06	31,120	24,010	to 38,231
5	FNG	05/04/10	09/08/10	22.5	26.7	0.48	0.06	28,138	20,835	to 35,442

Estimates of survival for the 6th release cohort of fingerlings in RPMA 2 (cohort= 40,948 fish, 49% released in Missouri, IV status = 0, Fin Curl status = 0).

Release	Type	Start Date	End Date	Age at int. start (mos.)	Age at int end (mos.)	Ppn. Still Alive	(SE)	N at Interval End	(95% CI for N at Inteval End)	
6	FNG	09/15/09	05/04/10	2.7	10.4	0.78	0.04	31,945	28,839	to 35,051
6	FNG	05/04/10	09/08/10	10.4	14.6	0.70	0.05	28,474	24,551	to 32,396

Summary information for fingerings released in RPMA 2.

When the most recent estimates of the proportion surviving and the number surviving from each release cohort are assembled, one can review how many fish released as fingerlings are estimated to still be alive. As noted earlier, the point estimates indicate that sizeable numbers and proportions of fish are still alive in RPMA 2. There are estimated to be ~79,861 fish released as fingerlings alive in the river at the time of the last estimation date (09/08/2010). Of these ~93% (74,260) were \leq 3 years old, ~7% (5,566) were ~4- to 5-years old, and <1% (35) were \geq 6 years old.

Estimates of surviving proportions and numbers for fingerling releases in RPMA 2.

Release	Type	Date	Age in months	Age in years	Ppn. Still Alive	(SE)	N Alive	(95% CI for N Alive)	
1: 16,810	FNG	09/08/10	75.3	6.3	0.00	0.00	35	0	to 95
2: 12,469	FNG	09/08/10	63.0	5.3	0.26	0.06	3,180	1,728	to 4,632
3: 6,916	FNG	09/08/10	50.8	4.2	0.35	0.06	2,386	1,529	to 3,243
4: 41,469	FNG	09/08/10	38.8	3.2	0.43	0.06	17,648	12,476	to 22,820
5: 58,838	FNG	09/08/10	26.7	2.2	0.48	0.06	28,138	20,835	to 35,442
6: 40,948	FNG	09/08/10	14.6	1.2	0.70	0.05	28,474	24,551	to 32,396

Results for Releases of Spring Yearlings in RPMA 2

Data on the number of spring yearlings released on each occasion ($R(i)$) along with information on when they were 1st subsequently recaptured (on occasion j) is provided in the table below. At the time of the analyses presented here, 36,085 releases and re-releases of fish originally released as spring yearlings had been conducted, which resulted in 943 recaptures. The results presented below are based on the analyses of those 943 recaptures from 36,085 releases and re-releases.

Spring Yearlings																						Total	
occ.	R(i)	j=	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	Total
1	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	821				0	0	0	0	0	0	0	1	0	1	0	0	3	0	0	0	0	0	5
6	0					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	870						0	0	0	0	0	1	0	0	0	0	0	0	0	3	0	4	8
8	0							0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	6671								0	0	0	39	2	29	8	0	8	3	0	27	5	47	168
10	0									0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	41										0	0	0	1	0	0	0	0	0	1	0	1	3
12	3953											0	0	44	10	0	19	10	0	35	11	76	205
13	75														2	0	1	0	0	1	0	3	7
14	8025															0	40	15	0	41	5	58	159
15	0																0	0	0	0	0	0	0
16	71																	0	4	0	0	4	4
17	4910																		0	81	5	60	146
18	0																			0	0	0	0
19	193																				0	11	11
20	10455																					227	227

Estimates of survival for the 1st release cohort of spring yearlings (~9.6 months old at time of release, which was 4/13/2004) in RPMA 2. Estimates are for a fish without disease problems (no fin curl or iridovirus) and averaged across results for releases in Missouri and Yellowstone Rivers. *The updated estimates presented here are quite similar to those presented in Rotella (2010) for this release type in this RPMA. However, precision is somewhat better here, which is not surprising given that the number of recaptured individuals (from multiple release cohorts) increased markedly in the latest survey.*

Start Date	End Date	Months	Age at int.	Age at int.	Monthly Survival	(SE)	Ppn.	(SE)	(95% CI for Cum. Ppn. Surviving)
			start (mos.)	end (mos.)			Still Alive		
04/13/04	09/21/04	5.4	9.6	14.9	0.930	(0.007)	0.68	(0.03)	(0.63 to 0.73)
09/21/04	04/30/05	7.4	14.9	22.3	0.938	(0.005)	0.42	(0.03)	(0.36 to 0.49)
04/30/05	09/23/05	4.9	22.3	27.2	0.947	(0.004)	0.32	(0.03)	(0.26 to 0.38)
09/23/05	04/29/06	7.3	27.2	34.4	0.952	(0.003)	0.23	(0.03)	(0.18 to 0.28)
04/29/06	07/13/06	2.5	34.4	36.9	0.959	(0.004)	0.20	(0.02)	(0.16 to 0.25)
07/13/06	09/27/06	2.5	36.9	39.5	0.961	(0.004)	0.18	(0.02)	(0.14 to 0.23)
09/27/06	05/02/07	7.2	39.5	46.7	0.963	(0.004)	0.14	(0.02)	(0.10 to 0.18)
05/02/07	09/22/07	4.8	46.7	51.5	0.969	(0.004)	0.12	(0.02)	(0.09 to 0.16)
09/22/07	04/30/08	7.4	51.5	58.8	0.972	(0.005)	0.10	(0.02)	(0.07 to 0.13)
04/30/08	07/22/08	2.8	58.8	61.6	0.976	(0.005)	0.09	(0.02)	(0.06 to 0.12)
07/22/08	09/16/08	1.9	61.6	63.5	0.977	(0.005)	0.09	(0.02)	(0.06 to 0.12)
09/16/08	05/08/09	7.8	63.5	71.3	0.978	(0.005)	0.07	(0.02)	(0.04 to 0.10)
05/08/09	07/22/09	2.5	71.3	73.8	0.982	(0.005)	0.07	(0.02)	(0.04 to 0.10)
07/22/09	09/15/09	1.8	73.8	75.6	0.983	(0.005)	0.07	(0.02)	(0.04 to 0.10)
09/15/09	05/04/10	7.7	75.6	83.3	0.983	(0.005)	0.06	(0.02)	(0.03 to 0.09)
05/04/10	09/08/10	4.2	83.3	87.5	0.986	(0.005)	0.06	(0.02)	(0.03 to 0.09)

For spring yearlings, the estimates from the model that is best-supported by the data indicate that a smaller proportion of fish released as spring yearlings survive to later ages (e.g., age 6 years old) than was estimated for fish released as fingerlings (~0.07 [SE=0.02] versus ~0.29 [SE=0.06], respectively). Point estimates of the number of fish still alive at different times post-release for each cohort are provided below.

When the number of fish released in a cohort is taken into account, it is possible to estimate the number of fish from each cohort that is estimated to be alive through time. The tables below do this for each release type and cohort using **the average value for river of releases and for disease status in each release cohort**. Thus, these represent estimates based on the average covariate conditions experienced by a release cohort rather than an idealized cohort without disease that is averaged across releases on the Missouri and the Yellowstone Rivers, which is what was done in the table immediately above.

Estimates of survival for the 1st release cohort of spring yearlings in RPMA 2 (cohort= 821 fish, <0.1% released in Missouri, IV status = 0, Fin Curl status = 0).

Release	Type	Start Date	End Date	Age at int. start (mos.)	Age at int. end (mos.)	Ppn. Still Alive	(SE)	N at Interval End	(95% CI for N at Inteval End)		
1	SPR	04/13/04	09/21/04	9.6	14.9	0.71	0.02	583	543	to	623
1	SPR	09/21/04	04/30/05	14.9	22.3	0.47	0.03	384	331	to	437
1	SPR	04/30/05	09/23/05	22.3	27.2	0.37	0.03	304	253	to	354
1	SPR	09/23/05	04/29/06	27.2	34.4	0.27	0.03	221	176	to	267
1	SPR	04/29/06	07/13/06	34.4	36.9	0.25	0.03	202	159	to	245
1	SPR	07/13/06	09/27/06	36.9	39.5	0.23	0.03	185	143	to	226
1	SPR	09/27/06	05/02/07	39.5	46.7	0.18	0.02	146	108	to	183
1	SPR	05/02/07	09/22/07	46.7	51.5	0.15	0.02	127	92	to	163
1	SPR	09/22/07	04/30/08	51.5	58.8	0.13	0.02	106	72	to	139
1	SPR	04/30/08	07/22/08	58.8	61.6	0.12	0.02	99	66	to	133
1	SPR	07/22/08	09/16/08	61.6	63.5	0.12	0.02	96	63	to	129
1	SPR	09/16/08	05/08/09	63.5	71.3	0.10	0.02	82	50	to	115
1	SPR	05/08/09	07/22/09	71.3	73.8	0.10	0.02	79	47	to	111
1	SPR	07/22/09	09/15/09	73.8	75.6	0.09	0.02	77	44	to	109
1	SPR	09/15/09	05/04/10	75.6	83.3	0.08	0.02	68	36	to	101
1	SPR	05/04/10	09/08/10	83.3	87.5	0.08	0.02	65	32	to	98

Estimates of survival for the 2nd release cohort of spring yearlings in RPMA 2 (cohort= 870 fish, 64% released in Missouri, IV status = 0, Fin Curl status = 0).

Release	Type	Start Date	End Date	Age at int.		Ppn. Still Alive	Interval (SE)	N at			
				start (mos.)	end (mos.)			End	(95% CI for N at	Inteval End)	
2	SPR	04/30/05	09/23/05	9.6	14.4	0.70	0.03	607	563	to	650
2	SPR	09/23/05	04/29/06	14.4	21.7	0.43	0.03	374	317	to	431
2	SPR	04/29/06	07/13/06	21.7	24.2	0.37	0.03	324	269	to	380
2	SPR	07/13/06	09/27/06	24.2	26.7	0.33	0.03	283	230	to	336
2	SPR	09/27/06	05/02/07	26.7	34.0	0.23	0.03	196	151	to	240
2	SPR	05/02/07	09/22/07	34.0	38.7	0.18	0.02	159	120	to	198
2	SPR	09/22/07	04/30/08	38.7	46.1	0.14	0.02	119	86	to	153
2	SPR	04/30/08	07/22/08	46.1	48.9	0.12	0.02	109	77	to	141
2	SPR	07/22/08	09/16/08	48.9	50.7	0.12	0.02	103	72	to	134
2	SPR	09/16/08	05/08/09	50.7	58.5	0.09	0.02	81	53	to	109
2	SPR	05/08/09	07/22/09	58.5	61.0	0.09	0.02	76	49	to	104
2	SPR	07/22/09	09/15/09	61.0	62.9	0.08	0.02	73	46	to	100
2	SPR	09/15/09	05/04/10	62.9	70.6	0.07	0.02	61	35	to	87
2	SPR	05/04/10	09/08/10	70.6	74.8	0.06	0.02	56	31	to	82

Estimates of survival for the 3rd release cohort of spring yearlings in RPMA 2 (cohort= 6,671 fish, 66% released in Missouri, IV status = 0, Fin Curl status = 0.24).

Release	Type	Start Date	End Date	Age at int.		Ppn. Still Alive	Interval (SE)	N at			
				start (mos.)	end (mos.)			End	(95% CI for N at	Inteval End)	
3	SPR	04/29/06	07/13/06	9.6	12.1	0.79	0.02	5,275	5,043	to	5,508
3	SPR	07/13/06	09/27/06	12.1	14.6	0.63	0.03	4,212	3,864	to	4,559
3	SPR	09/27/06	05/02/07	14.6	21.8	0.34	0.03	2,290	1,886	to	2,694
3	SPR	05/02/07	09/22/07	21.8	26.6	0.24	0.03	1,623	1,273	to	1,974
3	SPR	09/22/07	04/30/08	26.6	34.0	0.15	0.02	1,005	739	to	1,271
3	SPR	04/30/08	07/22/08	34.0	36.7	0.13	0.02	862	622	to	1,102
3	SPR	07/22/08	09/16/08	36.7	38.6	0.12	0.02	782	557	to	1,007
3	SPR	09/16/08	05/08/09	38.6	46.4	0.08	0.01	529	353	to	706
3	SPR	05/08/09	07/22/09	46.4	48.9	0.07	0.01	476	311	to	642
3	SPR	07/22/09	09/15/09	48.9	50.7	0.07	0.01	443	283	to	602
3	SPR	09/15/09	05/04/10	50.7	58.4	0.05	0.01	330	192	to	468
3	SPR	05/04/10	09/08/10	58.4	62.7	0.04	0.01	288	157	to	418

Estimates of survival for the 4th release cohort of spring yearlings in RPMA 2 (cohort= 3,951 fish, 49% released in Missouri, IV status = 0, Fin Curl status = 0).

Release	Type	Start Date	End Date	Age at int.	Age at int	Ppn. Still Alive	Interval (SE)	N at End	N at	
				start (mos.)	end (mos.)				Interval	(95% CI for N at Inteval End)
4	SPR	05/02/07	09/22/07	9.6	14.3	0.71	0.02	2,810	2,621	to 2,998
4	SPR	09/22/07	04/30/08	14.3	21.7	0.44	0.03	1,747	1,494	to 2,001
4	SPR	04/30/08	07/22/08	21.7	24.5	0.38	0.03	1,501	1,256	to 1,746
4	SPR	07/22/08	09/16/08	24.5	26.3	0.34	0.03	1,363	1,126	to 1,599
4	SPR	09/16/08	05/08/09	26.3	34.1	0.23	0.03	926	726	to 1,125
4	SPR	05/08/09	07/22/09	34.1	36.6	0.21	0.02	834	646	to 1,021
4	SPR	07/22/09	09/15/09	36.6	38.5	0.20	0.02	775	596	to 955
4	SPR	09/15/09	05/04/10	38.5	46.2	0.15	0.02	579	426	to 732
4	SPR	05/04/10	09/08/10	46.2	50.4	0.13	0.02	505	362	to 649

Estimates of survival for the 5th release cohort of spring yearlings in RPMA 2 (cohort= 8,005 fish, 62% released in Missouri, IV status = 0, Fin Curl status = 0.26).

Release	Type	Start Date	End Date	Age at int.	Age at int	Ppn. Still Alive	Interval (SE)	N at End	N at	
				start (mos.)	end (mos.)				Interval	(95% CI for N at Inteval End)
5	SPR	04/30/08	07/22/08	9.6	12.3	0.77	0.02	6,159	5,858	to 6,459
5	SPR	07/22/08	09/16/08	12.3	14.2	0.65	0.03	5,212	4,813	to 5,612
5	SPR	09/16/08	05/08/09	14.2	22	0.33	0.03	2,672	2,190	to 3,153
5	SPR	05/08/09	07/22/09	22	24.5	0.28	0.03	2,229	1,783	to 2,675
5	SPR	07/22/09	09/15/09	24.5	26.3	0.25	0.03	1,966	1,548	to 2,384
5	SPR	09/15/09	05/04/10	26.3	34.0	0.15	0.02	1,183	871	to 1,496
5	SPR	05/04/10	09/08/10	34.0	38.2	0.12	0.02	935	668	to 1,202

Estimates of survival for the 6th release cohort of spring yearlings in RPMA 2 (cohort= 4,882 fish, 37% released in Missouri, IV status = 0, Fin Curl status = 0.23).

Release	Type	Start Date	End Date	Age at int.	Age at int	Ppn. Still Alive	Interval (SE)	N at End	N at	
				start (mos.)	end (mos.)				Interval	(95% CI for N at Inteval End)
6	SPR	05/08/09	07/22/09	9.6	12.1	0.80	0.02	3,925	3,770	to 4,081
6	SPR	07/22/09	09/15/09	12.1	13.9	0.69	0.02	3,374	3,157	to 3,592
6	SPR	09/15/09	05/04/10	13.9	21.6	0.37	0.03	1,830	1,541	to 2,119
6	SPR	05/04/10	09/08/10	21.6	25.8	0.28	0.03	1,377	1,117	to 1,637

Summary information for spring yearlings released in RPMA 2.

When the most recent estimates of the proportion surviving and the number surviving from each release cohort are assembled, one can review how many fish released as spring yearlings are estimated to still be alive. The point estimates indicate that ~3,226 fish of different ages might still be alive in RPMA 2, that ~72% of those are ≤ 3 years old, ~25% are 4- to 5-years old, and ~4% (121) are ~6 years old or older .

Estimates of surviving proportions and numbers for spring yearlings released in RPMA 2.

Release	Type	Date	Age in months	Age in years	Ppn. Still Alive	(SE)	N Alive	(95% CI for N Alive)		
1: 821	SPR	09/08/10	87.5	7.3	0.08	0.02	65	32	to	98
2: 870	SPR	09/08/10	74.8	6.2	0.06	0.02	56	31	to	82
3: 6,671	SPR	09/08/10	62.7	5.2	0.04	0.01	288	157	to	418
4: 3,951	SPR	09/08/10	50.4	4.2	0.13	0.02	505	362	to	649
5: 8,005	SPR	09/08/10	38.2	3.2	0.12	0.02	935	668	to	1,202
6: 4,882	SPR	09/08/10	25.8	2.2	0.28	0.03	1,377	1,117	to	1,637

Results for Releases of Summer Yearlings in RPMA 2

Data on the number of summer yearlings released on each occasion ($R(i)$) along with information on when they were 1st subsequently recaptured (on occasion j) is provided in the table below. At the time of the analyses presented here, 18,912 releases and re-releases of fish originally released as summer yearlings had been conducted, which resulted in 569 recaptures. The results presented below are based on the analyses of those 569 recaptures from 18,912 releases and re-releases.

Summer Yearlings																						Total
occ.	R(i)	j= 2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	Total
1	789	0	0	0	0	3	0	3	1	0	2	0	1	2	0	3	0	0	4	12	8	39
2	478		0	0	0	2	0	1	0	0	0	0	1	0	0	1	0	0	4	0	6	15
3	3089			0	0	13	7	9	1	0	4	3	13	5	0	14	0	0	15	6	24	114
4	4010				0	20	0	18	2	0	6	0	10	0	0	8	0	0	7	12	44	127
5	0					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	1624						4	10	0	0	8	0	7	1	0	3	0	0	6	0	11	50
7	11							0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	216								1	0	0	1	1	0	0	0	0	0	0	0	1	4
9	5									0	0	0	0	0	0	0	0	0	0	0	0	0
10	1363																2	0	4	1	9	65
11	52										32	0	2	0	0	0	0	0	0	0	0	2
12	4											0	0	0	0	0	0	0	0	0	0	0
13	44												0	1	0	4	0	0	2	0	2	9
14	12														0	0	0	0	1	0	0	1
15	3260															25	3	0	19	3	28	78
16	63																1	0	2	1	6	10
17	6																	0	0	0	0	0
18	3780																		0	6	38	44
19	64																			1	6	7
20	42																				4	4

Estimates of survival for the 1st release cohort of summer yearlings (~13.9 months old at time of release, which was 8/11/1998) in RPMA 2. Estimates are for a fish without disease problems (no fin curl or iridovirus) and averaged across results for releases in Missouri and Yellowstone Rivers. *The estimates here are ~1/2 as large as the estimates for this release type in the most recent report. Precision of estimates has improved, which is in agreement with what would be expected given the growing number of recaptures made in recent sampling for this group.*

Start Date	End Date	Months	Age at int. start (mos.)	Age at int end (mos.)	Monthly Survival	(SE)	Ppn. Still Alive	(SE)	(95% CI for Cum. Ppn. Surviving)
08/11/98	10/14/00	26.5	13.9	40.4	0.940	(0.007)	0.19	(0.04)	(0.11 to 0.27)
10/14/00	08/18/02	22.4	40.4	62.8	0.966	(0.002)	0.09	(0.02)	(0.05 to 0.12)
08/18/02	08/17/03	12.1	62.8	74.9	0.979	(0.003)	0.07	(0.01)	(0.04 to 0.09)
08/17/03	04/13/04	8.0	74.9	82.9	0.984	(0.004)	0.06	(0.01)	(0.04 to 0.08)
04/13/04	09/21/04	5.4	82.9	88.3	0.987	(0.004)	0.06	(0.01)	(0.04 to 0.08)
09/21/04	04/30/05	7.4	88.3	95.7	0.988	(0.004)	0.05	(0.01)	(0.03 to 0.07)
04/30/05	09/23/05	4.9	95.7	100.5	0.990	(0.003)	0.05	(0.01)	(0.03 to 0.07)
09/23/05	04/29/06	7.3	100.5	107.8	0.991	(0.003)	0.05	(0.01)	(0.03 to 0.06)
04/29/06	07/13/06	2.5	107.8	110.3	0.992	(0.003)	0.04	(0.01)	(0.03 to 0.06)
07/13/06	09/27/06	2.5	110.3	112.8	0.993	(0.003)	0.04	(0.01)	(0.03 to 0.06)
09/27/06	05/02/07	7.2	112.8	120.1	0.993	(0.003)	0.04	(0.01)	(0.03 to 0.06)
05/02/07	09/22/07	4.8	120.1	124.8	0.994	(0.003)	0.04	(0.01)	(0.03 to 0.06)
09/22/07	04/30/08	7.4	124.8	132.2	0.995	(0.003)	0.04	(0.01)	(0.02 to 0.05)
04/30/08	07/22/08	2.8	132.2	135.0	0.996	(0.002)	0.04	(0.01)	(0.02 to 0.05)
07/22/08	09/16/08	1.9	135.0	136.8	0.996	(0.002)	0.04	(0.01)	(0.02 to 0.05)
09/16/08	05/08/09	7.8	136.8	144.7	0.996	(0.002)	0.04	(0.01)	(0.02 to 0.05)
05/08/09	07/22/09	2.5	144.7	147.2	0.997	(0.002)	0.04	(0.01)	(0.02 to 0.05)
07/22/09	09/15/09	1.8	147.2	149.0	0.997	(0.002)	0.04	(0.01)	(0.02 to 0.05)
09/15/09	05/04/10	7.7	149.0	156.7	0.997	(0.002)	0.04	(0.01)	(0.02 to 0.05)
05/04/10	09/08/10	4.2	156.7	160.9	0.997	(0.002)	0.04	(0.01)	(0.02 to 0.05)

For summer yearlings, the estimates from the model that is best-supported by the data indicate that the proportion of fish released as summer yearlings that survive to later ages (e.g., ~0.04 [SE=0.01]) of individuals estimated to still be alive age 6 years old) is similar to what was found for fish released as spring yearlings (~0.06 [SE=0.02]) and lower than what was estimated for fish released as fingerlings (~0.29 [SE=0.06], respectively).

The tables below do this for each release type and cohort using **the average value for river of releases and for disease status in each release cohort.** Thus, these represent estimates based on the average covariate conditions experienced by a release cohort rather than an idealized cohort without disease that is averaged across releases on the Missouri and the Yellowstone Rivers, which is what was done in the table immediately above.

Estimates of survival for the 1st release cohort of summer yearlings in RPMA 2 (cohort= 789 fish, 38% released in Missouri, IV status not considered, Fin Curl status = 0).

Release	Type	Start Date	End Date	Age at int. start (mos.)	Age at int. end (mos.)	Ppn. Still Alive	(SE)	N at Interval End	(95% CI for N at Inteval End)	
1	SUM	08/11/98	10/14/00	13.9	40.4	0.20	0.04	161	99	to 223
1	SUM	10/14/00	08/18/02	40.4	62.8	0.10	0.02	76	45	to 106
1	SUM	08/18/02	08/17/03	62.8	74.9	0.07	0.01	59	37	to 81
1	SUM	08/17/03	04/13/04	74.9	82.9	0.07	0.01	52	34	to 71
1	SUM	04/13/04	09/21/04	82.9	88.3	0.06	0.01	49	32	to 66
1	SUM	09/21/04	04/30/05	88.3	95.7	0.06	0.01	45	29	to 60
1	SUM	04/30/05	09/23/05	95.7	100.5	0.05	0.01	43	28	to 57
1	SUM	09/23/05	04/29/06	100.5	107.8	0.05	0.01	40	26	to 54
1	SUM	04/29/06	07/13/06	107.8	110.3	0.05	0.01	39	25	to 53
1	SUM	07/13/06	09/27/06	110.3	112.8	0.05	0.01	39	25	to 52
1	SUM	09/27/06	05/02/07	112.8	120.1	0.05	0.01	37	23	to 50
1	SUM	05/02/07	09/22/07	120.1	124.8	0.05	0.01	36	22	to 49
1	SUM	09/22/07	04/30/08	124.8	132.2	0.04	0.01	34	21	to 48
1	SUM	04/30/08	07/22/08	132.2	135.0	0.04	0.01	34	21	to 47
1	SUM	07/22/08	09/16/08	135.0	136.8	0.04	0.01	34	20	to 47
1	SUM	09/16/08	05/08/09	136.8	144.7	0.04	0.01	33	19	to 46
1	SUM	05/08/09	07/22/09	144.7	147.2	0.04	0.01	32	19	to 46
1	SUM	07/22/09	09/15/09	147.2	149.0	0.04	0.01	32	19	to 46
1	SUM	09/15/09	05/04/10	149.0	156.7	0.04	0.01	32	18	to 45
1	SUM	05/04/10	09/08/10	156.7	160.9	0.04	0.01	31	17	to 45

Estimates of survival for the 2nd release cohort of summer yearlings in RPMA 2 (cohort= 478 fish, 37% released in Missouri, IV status not considered, Fin Curl status = 0).

Release	Type	Start Date	End Date	Age at int.	Age at int.	Ppn. Still Alive	(SE)	N at	(95% CI for N at Inteval End)		
				start (mos.)	end (mos.)			Interval End			
2	SUM	10/14/00	08/18/02	13.9	36.3	0.26	0.04	124	84	to	165
2	SUM	08/18/02	08/17/03	36.3	48.4	0.17	0.03	80	52	to	108
2	SUM	08/17/03	04/13/04	48.4	56.4	0.13	0.02	64	42	to	85
2	SUM	04/13/04	09/21/04	56.4	61.8	0.12	0.02	56	38	to	75
2	SUM	09/21/04	04/30/05	61.8	69.2	0.10	0.02	48	33	to	63
2	SUM	04/30/05	09/23/05	69.2	74.0	0.09	0.01	44	30	to	58
2	SUM	09/23/05	04/29/06	74.0	81.3	0.08	0.01	39	27	to	51
2	SUM	04/29/06	07/13/06	81.3	83.8	0.08	0.01	38	26	to	50
2	SUM	07/13/06	09/27/06	83.8	86.3	0.08	0.01	37	26	to	48
2	SUM	09/27/06	05/02/07	86.3	93.6	0.07	0.01	34	23	to	44
2	SUM	05/02/07	09/22/07	93.6	98.3	0.07	0.01	32	22	to	42
2	SUM	09/22/07	04/30/08	98.3	105.7	0.06	0.01	30	20	to	40
2	SUM	04/30/08	07/22/08	105.7	108.5	0.06	0.01	29	19	to	39
2	SUM	07/22/08	09/16/08	108.5	110.4	0.06	0.01	29	19	to	39
2	SUM	09/16/08	05/08/09	110.4	118.2	0.06	0.01	27	17	to	37
2	SUM	05/08/09	07/22/09	118.2	120.7	0.06	0.01	27	17	to	37
2	SUM	07/22/09	09/15/09	120.7	122.5	0.06	0.01	27	17	to	37
2	SUM	09/15/09	05/04/10	122.5	130.2	0.05	0.01	26	15	to	36
2	SUM	05/04/10	09/08/10	130.2	134.4	0.05	0.01	25	15	to	35

Estimates of survival for the 3rd release cohort of summer yearlings in RPMA 2 (cohort= 3,089 fish, 42% released in Missouri, IV status not considered, Fin Curl status = 0.05).

Release	Type	Start Date	End Date	Age at int.	Age at int.	Ppn. Still Alive	Interval (SE)	N at	(95% CI for N at		
				start (mos.)	end (mos.)			End	Inteval	End)	
3	SUM	08/18/02	08/17/03	13.9	26.0	0.46	0.04	1,427	1,161	to	1,693
3	SUM	08/17/03	04/13/04	26.0	34.0	0.31	0.04	966	735	to	1,196
3	SUM	04/13/04	09/21/04	34.0	39.4	0.25	0.03	775	578	to	972
3	SUM	09/21/04	04/30/05	39.4	46.7	0.19	0.03	593	436	to	749
3	SUM	04/30/05	09/23/05	46.7	51.6	0.17	0.02	510	375	to	644
3	SUM	09/23/05	04/29/06	51.6	58.9	0.13	0.02	416	307	to	526
3	SUM	04/29/06	07/13/06	58.9	61.4	0.13	0.02	393	290	to	495
3	SUM	07/13/06	09/27/06	61.4	63.9	0.12	0.02	371	274	to	468
3	SUM	09/27/06	05/02/07	63.9	71.1	0.10	0.01	318	234	to	403
3	SUM	05/02/07	09/22/07	71.1	75.9	0.09	0.01	292	213	to	371
3	SUM	09/22/07	04/30/08	75.9	83.3	0.08	0.01	259	185	to	334
3	SUM	04/30/08	07/22/08	83.3	86.0	0.08	0.01	250	176	to	323
3	SUM	07/22/08	09/16/08	86.1	87.9	0.08	0.01	244	170	to	317
3	SUM	09/16/08	05/08/09	87.9	95.7	0.07	0.01	221	149	to	294
3	SUM	05/08/09	07/22/09	95.7	98.2	0.07	0.01	215	143	to	288
3	SUM	07/22/09	09/15/09	98.2	100.0	0.07	0.01	212	139	to	285
3	SUM	09/15/09	05/04/10	100.1	107.8	0.06	0.01	197	122	to	271
3	SUM	05/04/10	09/08/10	107.8	112.0	0.06	0.01	190	115	to	266

Estimates of survival for the 4th release cohort of summer yearlings in RPMA 2 (cohort= 4,010 fish, 51% released in Missouri, IV status not considered, Fin Curl status = 0).

Release	Type	Start Date	End Date	Age at int.	Age at int.	Ppn. Still Alive	Interval (SE)	N at	(95% CI for N at Inteval End)		
				start (mos.)	end (mos.)			End			
4	SUM	08/17/03	04/13/04	13.9	21.9	0.61	0.04	2,442	2,146	to	2,737
4	SUM	04/13/04	09/21/04	21.9	27.2	0.46	0.04	1,846	1,533	to	2,159
4	SUM	09/21/04	04/30/05	27.2	34.6	0.33	0.04	1,312	1,032	to	1,592
4	SUM	04/30/05	09/23/05	34.6	39.5	0.27	0.03	1,083	837	to	1,330
4	SUM	09/23/05	04/29/06	39.5	46.8	0.21	0.03	838	637	to	1,038
4	SUM	04/29/06	07/13/06	46.8	49.2	0.19	0.02	777	591	to	963
4	SUM	07/13/06	09/27/06	49.2	51.8	0.18	0.02	723	550	to	896
4	SUM	09/27/06	05/02/07	51.8	59.0	0.15	0.02	595	451	to	739
4	SUM	05/02/07	09/22/07	59.0	63.8	0.13	0.02	533	403	to	663
4	SUM	09/22/07	04/30/08	63.8	71.1	0.11	0.01	458	343	to	573
4	SUM	04/30/08	07/22/08	71.2	73.9	0.11	0.01	436	325	to	548
4	SUM	07/22/08	09/16/08	73.9	75.8	0.11	0.01	423	313	to	533
4	SUM	09/16/08	05/08/09	75.8	83.6	0.09	0.01	374	269	to	479
4	SUM	05/08/09	07/22/09	83.6	86.1	0.09	0.01	362	257	to	466
4	SUM	07/22/09	09/15/09	86.1	87.9	0.09	0.01	353	249	to	457
4	SUM	09/15/09	05/04/10	87.9	95.6	0.08	0.01	322	218	to	426
4	SUM	05/04/10	09/08/10	95.6	99.9	0.08	0.01	309	203	to	414

Estimates of survival for the 5th release cohort of summer yearlings in RPMA 2 (cohort= 1,586 fish, 57% released in Missouri, IV status not considered, Fin Curl status = 0).

Release	Type	Start Date	End Date	Age at int.	Age at int.	Ppn. Still Alive	Interval (SE)	N at	(95% CI for N at Inteval End)		
				start (mos.)	end (mos.)			End			
5	SUM	09/21/04	04/30/05	13.9	21.2	0.63	0.04	998	885	to	1,111
5	SUM	04/30/05	09/23/05	21.2	26.1	0.49	0.04	769	646	to	892
5	SUM	09/23/05	04/29/06	26.1	33.4	0.34	0.04	543	429	to	656
5	SUM	04/29/06	07/13/06	33.4	35.9	0.31	0.03	490	384	to	596
5	SUM	07/13/06	09/27/06	35.9	38.4	0.28	0.03	444	345	to	543
5	SUM	09/27/06	05/02/07	38.4	45.6	0.21	0.03	341	260	to	421
5	SUM	05/02/07	09/22/07	45.6	50.4	0.18	0.02	293	223	to	364
5	SUM	09/22/07	04/30/08	50.4	57.8	0.15	0.02	238	180	to	296
5	SUM	04/30/08	07/22/08	57.8	60.5	0.14	0.02	223	169	to	277
5	SUM	07/22/08	09/16/08	60.5	62.4	0.13	0.02	214	162	to	266
5	SUM	09/16/08	05/08/09	62.4	70.2	0.11	0.01	181	135	to	226
5	SUM	05/08/09	07/22/09	70.2	72.7	0.11	0.01	173	129	to	217
5	SUM	07/22/09	09/15/09	72.7	74.5	0.11	0.01	167	124	to	211
5	SUM	09/15/09	05/04/10	74.5	82.2	0.09	0.01	147	106	to	189
5	SUM	05/04/10	09/08/10	82.2	86.5	0.09	0.01	139	98	to	180

Estimates of survival for the 6th release cohort of summer yearlings in RPMA 2 (cohort= 175 fish, 0% released in Missouri, IV status not considered, Fin Curl status = 1).

Release	Type	Start Date	End Date	Age at int.		Ppn. Still Alive	Interval (SE)	N at End	(95% CI for N at Inteval End)	
				start (mos.)	end (mos.)					
6	SUM	09/23/05	04/29/06	13.9	21.1	0.35	0.05	61	43	to 79
6	SUM	04/29/06	07/13/06	21.1	23.6	0.26	0.05	45	28	to 61
6	SUM	07/13/06	09/27/06	23.6	26.2	0.19	0.04	33	19	to 47
6	SUM	09/27/06	05/02/07	26.2	33.4	0.08	0.03	15	6	to 24
6	SUM	05/02/07	09/22/07	33.4	38.2	0.05	0.02	9	3	to 16
6	SUM	09/22/07	04/30/08	38.2	45.5	0.03	0.01	5	1	to 9
6	SUM	04/30/08	07/22/08	45.5	48.3	0.02	0.01	4	1	to 7
6	SUM	07/22/08	09/16/08	48.3	50.2	0.02	0.01	4	0	to 7
6	SUM	09/16/08	05/08/09	50.2	58.0	0.01	0.01	2	0	to 4
6	SUM	05/08/09	07/22/09	58.0	60.5	0.01	0.01	2	0	to 4
6	SUM	07/22/09	09/15/09	60.5	62.3	0.01	0	2	0	to 3
6	SUM	09/15/09	05/04/10	62.3	70.0	0.01	0	1	0	to 2
6	SUM	05/04/10	09/08/10	70.0	74.2	0.01	0	1	0	to 2

Estimates of survival for the 7th release cohort of summer yearlings in RPMA 2 (cohort= 1,363 fish, 67% released in Missouri, IV status not considered, Fin Curl status = 0).

Release	Type	Start Date	End Date	Age at int.		Ppn. Still Alive	Interval (SE)	N at End	(95% CI for N at Inteval End)	
				start (mos.)	end (mos.)					
7	SUM	07/13/06	09/27/06	13.9	16.4	0.85	0.02	1,158	1,112	to 1,205
7	SUM	09/27/06	05/02/07	16.4	23.6	0.55	0.04	746	643	to 850
7	SUM	05/02/07	09/22/07	23.6	28.4	0.43	0.04	582	478	to 686
7	SUM	09/22/07	04/30/08	28.4	35.8	0.30	0.03	412	321	to 504
7	SUM	04/30/08	07/22/08	35.8	38.5	0.27	0.03	369	285	to 454
7	SUM	07/22/08	09/16/08	38.5	40.4	0.25	0.03	344	264	to 424
7	SUM	09/16/08	05/08/09	40.4	48.2	0.19	0.02	260	196	to 324
7	SUM	05/08/09	07/22/09	48.2	50.7	0.18	0.02	241	182	to 301
7	SUM	07/22/09	09/15/09	50.7	52.5	0.17	0.02	229	172	to 285
7	SUM	09/15/09	05/04/10	52.5	60.2	0.14	0.02	185	139	to 232
7	SUM	05/04/10	09/08/10	60.2	64.5	0.12	0.02	168	125	to 210

Estimates of survival for the 8th release cohort of summer yearlings in RPMA 2 (cohort= 3,260 fish, 21% released in Missouri, IV status not considered, Fin Curl status = 0).

Release	Type	Start Date	End Date	Age at int.	Age at int.	Ppn. Still Alive	(SE)	N at	(95% CI for N at Inteval End)		
				start (mos.)	end (mos.)			Interval End			
8	SUM	07/22/08	09/16/08	13.9	15.7	0.90	0.01	2,926	2,849	to	3,004
8	SUM	09/16/08	05/08/09	15.7	23.5	0.58	0.04	1,899	1,662	to	2,137
8	SUM	05/08/09	07/22/09	23.5	26.0	0.52	0.04	1,690	1,447	to	1,933
8	SUM	07/22/09	09/15/09	26.0	27.9	0.48	0.04	1,558	1,317	to	1,800
8	SUM	09/15/09	05/04/10	27.9	35.6	0.34	0.03	1,123	902	to	1,345
8	SUM	05/04/10	09/08/10	35.6	39.8	0.30	0.03	965	764	to	1,166

Estimates of survival for the 9th release cohort of summer yearlings in RPMA 2 (cohort= 3,780 fish, 53% released in Missouri, IV status not considered, Fin Curl status = 0).

Release	Type	Start Date	End Date	Age at int.	Age at int.	Ppn. Still Alive	(SE)	N at	(95% CI for N at Inteval End)		
				start (mos.)	end (mos.)			Interval End			
9	SUM	07/22/09	09/15/09	13.9	15.7	0.89	0.01	3,373	3,279	to	3,467
9	SUM	09/15/09	05/04/10	15.7	23.4	0.56	0.04	2,129	1,846	to	2,411
9	SUM	05/04/10	09/08/10	23.4	27.6	0.45	0.04	1,719	1,432	to	2,006

When the most recent estimates of the proportion surviving and the number surviving from each release cohort are assembled, one can review how many fish released as summer yearlings are estimated to still be alive. The point estimates indicate that ~3,547 fish of different ages were still alive in RPMA 2 at the time of the most recent survey used here (09/08/2010), that ~76% (2,684) of those are ≤ 3.5 years old, ~23% (807) were 5- to 9-years old, ~20% (695) were ≥ 6 years old, and ~2% (56) were > 10 years old.

Estimates of surviving proportions and numbers for summer yearlings released in RPMA 2.

Release	Type	Date	Age in months	Age in years	Ppn. Still Alive	(SE)	N Alive	(95% CI for N Alive)	
1: 789	SUM	09/08/10	160.9	13.4	0.04	0.01	31	17	to 45
2: 478	SUM	09/08/10	134.4	11.2	0.05	0.01	25	15	to 35
3: 3,089	SUM	09/08/10	112.0	9.3	0.06	0.01	190	115	to 266
4: 4,010	SUM	09/08/10	99.9	8.3	0.08	0.01	309	203	to 414
5: 1,586	SUM	09/08/10	86.5	7.2	0.09	0.01	139	98	to 180
6: 175	SUM	09/08/10	74.2	6.2	0.01	0	1	0	to 2
7: 1,363	SUM	09/08/10	64.5	5.4	0.12	0.02	168	125	to 210
8: 3,260	SUM	09/08/10	39.8	3.3	0.30	0.03	965	764	to 1,166
9: 3,780	SUM	09/08/10	27.6	2.3	0.45	0.04	1,719	1,432	to 2,006

Summary of number alive as of 09/08/2010 across all releases of fish in RPMA 2. *The previous reports did not provide such information and so such information is new for these analyses. Accordingly, comparisons with previous results cannot be made and will not appear for any RPMA.*

Release*	Type	Date	Age in years	N Alive	(95% CI for N Alive)	
6: 40,948	FNG	09/08/10	1.2	28,474	24,551 to	32,396
6: 4,882	SPR	09/08/10	2.2	1,377	1,117 to	1,637
5: 58,838	FNG	09/08/10	2.2	28,138	20,835 to	35,442
9: 3,780	SUM	09/08/10	2.3	1,719	1,432 to	2,006
5: 8,005	SPR	09/08/10	3.2	935	668 to	1,202
4: 41,469	FNG	09/08/10	3.2	17,648	12,476 to	22,820
8: 3,260	SUM	09/08/10	3.3	965	764 to	1,166
4: 3,951	SPR	09/08/10	4.2	505	362 to	649
3: 6,916	FNG	09/08/10	4.2	2,386	1,529 to	3,243
3: 6,671	SPR	09/08/10	5.2	288	157 to	418
2: 12,469	FNG	09/08/10	5.3	3,180	1,728 to	4,632
7: 1,363	SUM	09/08/10	5.4	168	125 to	210
6: 175	SUM	09/08/10	6.2	31	17 to	45
2: 870	SPR	09/08/10	6.2	56	31 to	82
1: 16,810	FNG	09/08/10	6.3	35	0 to	95
5: 1,586	SUM	09/08/10	7.2	1	0 to	2
1: 821	SPR	09/08/10	7.3	65	32 to	98
4: 4,010	SUM	09/08/10	8.3	139	98 to	180
3: 3,089	SUM	09/08/10	9.3	309	203 to	414
2: 478	SUM	09/08/10	11.2	25	15 to	35
1: 789	SUM	09/08/10	13.4	190	115 to	266

*The Release column represents (a) the release cohort for the specific type of release and (b) the number of individuals in that release cohort.

When summarized by age class, the estimates indicate that 86,634 of the fish that were released from hatcheries in recent years in RPMA 2 were still alive there in September of 2010. The majority of these fish were estimated to be in the younger classes: ~69% were estimated to be in the 1- to 2-yr-old class, ~30% were in the 3- to 5-year-old class, ~0.1% were 6- to 9-years old, and <0.1% were ≥ 11 years old.

RPMA	Date	Age in years	N Alive	(Sum of 95% CI elements for N Alive)	
2	09/08/10	1 to 2	59,708	47,935 to	71,481
2	09/08/10	3 to 5	26,075	17,809 to	34,340
2	09/08/10	6 to 9	636	381 to	916
2	09/08/10	>11	215	130 to	301

RPMA 2 – Estimates of Survival and Numbers Adjusted for PIT Tag Retention Rates

For Spring and Summer Yearlings released in RPMA 2 after 2003, the possible loss of PIT tags was of concern. If individuals in these cohorts lost their PIT tags prior to first capture, they could not be identified to release cohort in a way that let them be used in survival analysis, which biases survival downwards because such fish could not be known to have survived (i.e., they appear to have died even if still alive but without an identifying PIT tag). Accordingly, data on the numbers of individuals that were caught with or without PIT tags when recaptured at 1 to 12 years post release were used to estimate PIT retention rates in Spring & Summer Yearlings. Those estimates were subsequently used to adjust survival rates and population estimates upwards.

The data on PIT tag retention were analyzed in Program MARK using the nest-survival module, which is appropriate for known-fate data with different intervals between checks. The approach was to model the survival rate of a PIT tag (i.e., tag retention rate) as function of time since deployment. A variety of models were tried, and these competing models allowed tag retention rate to (1) be constant over time; (2) follow a trend through time, or (3) be different in the first 1, 2, or 3 years after release. The best-supported model indicated that tag retention rate was lower in the 1st three years after release and then higher and constant in subsequent years. The estimated annual rates of tag retention were 0.85 (SE = 0.10) for each of the 1st three years post release and 0.99 (SE = 0.01) in subsequent years.

The annual rates of tag retention were transformed to monthly tag retention rates (TR), which were used along with unadjusted monthly survival rates ($\hat{S}_{monthly}^{unadjusted}$) to calculate adjusted monthly survival rates

$\hat{S}_{monthly}^{adjusted}$ as follows: $\hat{S}_{monthly}^{adjusted} = \hat{S}_{monthly}^{unadjusted} / TR$. If, for example, annual tag retention rate were 0.87, the

monthly tag retention rate would be $\sqrt[12]{0.87} = 0.9885$. With an annual tag retention rate of 0.87, annual survival rate would be adjusted by dividing the annual survival rate by 0.87 (equivalent to multiplying the annual survival rate by 1.15), which would result in increasing the annual survival rate by 15% (with the constraint that the adjusted survival rate was not allowed to exceed 1.0). Although the example uses annual rates for ease of presentation, all adjustments were done at the level of monthly rates as this was the temporal scale of analysis used in all survival analyses.

In the tables that follow, tables of survival and abundance estimates for those cohorts of Spring & Summer yearlings that were released after 2003 are presented using values that are adjusted for PIT Tag Retention rates being less than 1.0. These values can be compared to those in the tables above to see the effect of these adjustments. The table header for each table begins with gray-shaded text that reads, “**Tag-loss adjusted estimates**”.

Tag-loss adjusted estimates of survival for the 1st release cohort of spring yearlings in RPMA 2 (cohort= 821 fish, <0.1% released in Missouri, IV status = 0, Fin Curl status = 0).

Release	Type	Start Date	End Date	Age at int. start (mos.)	Age at int. end (mos.)	Ppn. Still Alive	(SE)	N at Interval End	(95% CI for N at Inteval End)	
1	SPR	04/13/04	09/21/04	9.6	14.9	0.76	0.03	628	585	to 670
1	SPR	09/21/04	04/30/05	14.9	22.3	0.56	0.04	457	395	to 520
1	SPR	04/30/05	09/23/05	22.3	27.2	0.47	0.04	387	323	to 451
1	SPR	09/23/05	04/29/06	27.2	34.4	0.38	0.04	312	249	to 375
1	SPR	04/29/06	07/13/06	34.4	36.9	0.36	0.04	294	232	to 356
1	SPR	07/13/06	09/27/06	36.9	39.5	0.34	0.04	279	217	to 340
1	SPR	09/27/06	05/02/07	39.5	46.7	0.30	0.04	243	181	to 304
1	SPR	05/02/07	09/22/07	46.7	51.5	0.26	0.04	213	155	to 272
1	SPR	09/22/07	04/30/08	51.5	58.8	0.22	0.03	179	123	to 235
1	SPR	04/30/08	07/22/08	58.8	61.6	0.21	0.03	169	113	to 224
1	SPR	07/22/08	09/16/08	61.6	63.5	0.20	0.03	163	107	to 218
1	SPR	09/16/08	05/08/09	63.5	71.3	0.17	0.03	141	86	to 196
1	SPR	05/08/09	07/22/09	71.3	73.8	0.17	0.03	136	81	to 191
1	SPR	07/22/09	09/15/09	73.8	75.6	0.16	0.03	133	77	to 188
1	SPR	09/15/09	05/04/10	75.6	83.3	0.15	0.03	119	63	to 176
1	SPR	05/04/10	09/08/10	83.3	87.5	0.14	0.04	114	57	to 171

Tag-loss adjusted estimates of survival for the 2nd release cohort of spring yearlings in RPMA 2 (cohort= 870 fish, 64% released in Missouri, IV status = 0, Fin Curl status = 0).

Release	Type	Start Date	End Date	Age at int.		Ppn. Still Alive	Interval (SE)	N at End	N at (95% CI for N at Inteval End)		
				start (mos.)	end (mos.)						
2 SPR		04/30/05	09/23/05	9.6	14.4	0.75	0.03	649	602	to	695
2 SPR		09/23/05	04/29/06	14.4	21.7	0.51	0.04	442	375	to	508
2 SPR		04/29/06	07/13/06	21.7	24.2	0.46	0.04	397	330	to	463
2 SPR		07/13/06	09/27/06	24.2	26.7	0.41	0.04	358	293	to	424
2 SPR		09/27/06	05/02/07	26.7	34.0	0.31	0.04	274	213	to	335
2 SPR		05/02/07	09/22/07	34.0	38.7	0.27	0.03	238	180	to	296
2 SPR		09/22/07	04/30/08	38.7	46.1	0.23	0.03	197	143	to	252
2 SPR		04/30/08	07/22/08	46.1	48.9	0.21	0.03	180	128	to	232
2 SPR		07/22/08	09/16/08	48.9	50.7	0.20	0.03	170	120	to	221
2 SPR		09/16/08	05/08/09	50.7	58.5	0.16	0.03	136	90	to	183
2 SPR		05/08/09	07/22/09	58.5	61.0	0.15	0.03	128	82	to	174
2 SPR		07/22/09	09/15/09	61.0	62.9	0.14	0.03	123	78	to	168
2 SPR		09/15/09	05/04/10	62.9	70.6	0.12	0.03	104	60	to	148
2 SPR		05/04/10	09/08/10	70.6	74.8	0.11	0.03	96	53	to	140

Tag-loss adjusted estimates of survival for the 3rd release cohort of spring yearlings in RPMA 2 (cohort= 6,671 fish, 66% released in Missouri, IV status = 0, Fin Curl status = 0.24).

Release	Type	Start Date	End Date	Age at int.		Ppn. Still Alive	Interval (SE)	N at End	N at (95% CI for N at Inteval End)		
				start (mos.)	end (mos.)						
3 SPR		04/29/06	07/13/06	9.6	12.1	0.82	0.02	5,460	5,222	to	5,697
3 SPR		07/13/06	09/27/06	12.1	14.6	0.68	0.03	4,513	4,146	to	4,880
3 SPR		09/27/06	05/02/07	14.6	21.8	0.41	0.04	2,710	2,238	to	3,182
3 SPR		05/02/07	09/22/07	21.8	26.6	0.31	0.03	2,052	1,615	to	2,488
3 SPR		09/22/07	04/30/08	26.6	34.0	0.21	0.03	1,406	1,039	to	1,773
3 SPR		04/30/08	07/22/08	34.0	36.7	0.19	0.03	1,253	909	to	1,597
3 SPR		07/22/08	09/16/08	36.7	38.6	0.17	0.03	1,166	835	to	1,497
3 SPR		09/16/08	05/08/09	38.6	46.4	0.13	0.02	879	590	to	1,167
3 SPR		05/08/09	07/22/09	46.4	48.9	0.12	0.02	793	521	to	1,066
3 SPR		07/22/09	09/15/09	48.9	50.7	0.11	0.02	739	476	to	1,002
3 SPR		09/15/09	05/04/10	50.7	58.4	0.08	0.02	555	325	to	786
3 SPR		05/04/10	09/08/10	58.4	62.7	0.07	0.02	487	268	to	706

Tag-loss adjusted estimates of survival for the 4th release cohort of spring yearlings in RPMA 2 (cohort= 3,951 fish, 49% released in Missouri, IV status = 0, Fin Curl status = 0).

Release	Type	Start Date	End Date	Age at int.	Age at int	Ppn. Still Alive	Interval (SE)	N at	(95% CI for N at	
				start (mos.)	end (mos.)			End	Interval End)	
4 SPR		05/02/07	09/22/07	9.6	14.3	0.76	0.03	3,000	2,801	to 3,199
4 SPR		09/22/07	04/30/08	14.3	21.7	0.52	0.04	2,065	1,769	to 2,360
4 SPR		04/30/08	07/22/08	21.7	24.5	0.47	0.04	1,842	1,546	to 2,139
4 SPR		07/22/08	09/16/08	24.5	26.3	0.43	0.04	1,716	1,423	to 2,010
4 SPR		09/16/08	05/08/09	26.3	34.1	0.33	0.04	1,298	1,022	to 1,573
4 SPR		05/08/09	07/22/09	34.1	36.6	0.31	0.03	1,210	942	to 1,478
4 SPR		07/22/09	09/15/09	36.6	38.5	0.29	0.03	1,154	890	to 1,418
4 SPR		09/15/09	05/04/10	38.5	46.2	0.24	0.03	958	708	to 1,208
4 SPR		05/04/10	09/08/10	46.2	50.4	0.21	0.03	841	605	to 1,076

Tag-loss adjusted estimates of survival for the 5th release cohort of spring yearlings in RPMA 2 (cohort= 8,005 fish, 62% released in Missouri, IV status = 0, Fin Curl status = 0.26).

Release	Type	Start Date	End Date	Age at int.	Age at int	Ppn. Still Alive	Interval (SE)	N at	(95% CI for N at	
				start (mos.)	end (mos.)			End	Interval End)	
5 SPR		04/30/08	07/22/08	9.6	12.3	0.80	0.02	6,398	6,090	to 6,706
5 SPR		07/22/08	09/16/08	12.3	14.2	0.69	0.03	5,556	5,136	to 5,976
5 SPR		09/16/08	05/08/09	14.2	22	0.40	0.04	3,170	2,607	to 3,734
5 SPR		05/08/09	07/22/09	22	24.5	0.34	0.03	2,738	2,198	to 3,278
5 SPR		07/22/09	09/15/09	24.5	26.3	0.31	0.03	2,476	1,957	to 2,995
5 SPR		09/15/09	05/04/10	26.3	34.0	0.21	0.03	1,657	1,225	to 2,089
5 SPR		05/04/10	09/08/10	34.0	38.2	0.17	0.02	1,387	996	to 1,778

Tag-loss adjusted estimates of survival for the 6th release cohort of spring yearlings in RPMA 2 (cohort= 4,882 fish, 37% released in Missouri, IV status = 0, Fin Curl status = 0.23).

Release	Type	Start Date	End Date	Age at int.	Age at int	Ppn. Still Alive	Interval (SE)	N at	(95% CI for N at	
				start (mos.)	end (mos.)			End	Interval End)	
6 SPR		05/08/09	07/22/09	9.6	12.1	0.83	0.02	4,063	3,904	to 4,222
6 SPR		07/22/09	09/15/09	12.1	13.9	0.73	0.02	3,581	3,353	to 3,810
6 SPR		09/15/09	05/04/10	13.9	21.6	0.44	0.04	2,159	1,823	to 2,496
6 SPR		05/04/10	09/08/10	21.6	25.8	0.35	0.03	1,722	1,401	to 2,042

Summary information for tag-loss adjusted estimates of spring yearlings released in RPMA 2.

When the most recent estimates of the proportion surviving and the number surviving from each release cohort are assembled, one can review how many fish released as spring yearlings are estimated to still be alive. The *unadjusted* point estimates were ~3,226 total fish (across all ages) with ~72% ≤ 3 years old, ~25% 4- to 5-years old, and ~4% (121) ~6 years old or older. The *tag-loss adjusted estimates* indicate ~4,647 total fish (across all ages) with ~67% ≤ 3 years old, ~29% 4- to 5-years old, and ~5% that were ~6 years old or older.

Tag-loss adjusted estimates of surviving proportions and numbers for spring yearlings released in RPMA 2.

Release	Type	Date	Age in months	Age in years	Ppn. Still Alive	(SE)	N Alive	(95% CI for N Alive)		
1: 821	SPR	09/08/10	87.5	7.3	0.14	0.04	114	57	to	171
2: 870	SPR	09/08/10	74.8	6.2	0.11	0.03	96	53	to	140
3: 6,671	SPR	09/08/10	62.7	5.2	0.07	0.02	487	268	to	706
4: 3,951	SPR	09/08/10	50.4	4.2	0.21	0.03	841	605	to	1,076
5: 8,005	SPR	09/08/10	38.2	3.2	0.17	0.02	1,387	996	to	1,778
6: 4,882	SPR	09/08/10	25.8	2.2	0.35	0.03	1,722	1,401	to	2,042

Tag-loss adjusted estimates of survival for the 5th release cohort of summer yearlings in RPMA 2 (cohort= 1,586 fish, 57% released in Missouri, IV status not considered, Fin Curl status = 0).

Release	Type	Start Date	End Date	Age at int.		Ppn. Still Alive	Interval (SE)	N at End	(95% CI for N at Inteval End)		
				start (mos.)	end (mos.)						
5	SUM	09/21/04	04/30/05	13.9	21.2	0.70	0.04	1,105	981	to	1,228
5	SUM	04/30/05	09/23/05	21.2	26.1	0.57	0.05	911	767	to	1,054
5	SUM	09/23/05	04/29/06	26.1	33.4	0.45	0.05	709	564	to	855
5	SUM	04/29/06	07/13/06	33.4	35.9	0.42	0.05	663	521	to	804
5	SUM	07/13/06	09/27/06	35.9	38.4	0.39	0.04	622	485	to	759
5	SUM	09/27/06	05/02/07	38.4	45.6	0.33	0.04	527	404	to	650
5	SUM	05/02/07	09/22/07	45.6	50.4	0.31	0.04	485	370	to	600
5	SUM	09/22/07	04/30/08	50.4	57.8	0.25	0.03	398	302	to	493
5	SUM	04/30/08	07/22/08	57.8	60.5	0.24	0.03	373	284	to	463
5	SUM	07/22/08	09/16/08	60.5	62.4	0.23	0.03	359	272	to	445
5	SUM	09/16/08	05/08/09	62.4	70.2	0.19	0.02	306	230	to	383
5	SUM	05/08/09	07/22/09	70.2	72.7	0.19	0.02	294	219	to	368
5	SUM	07/22/09	09/15/09	72.7	74.5	0.18	0.02	285	212	to	358
5	SUM	09/15/09	05/04/10	74.5	82.2	0.16	0.02	254	183	to	324
5	SUM	05/04/10	09/08/10	82.2	86.5	0.15	0.02	240	170	to	310

Tag-loss adjusted estimates of survival for the 6th release cohort of summer yearlings in RPMA 2 (cohort= 175 fish, 0% released in Missouri, IV status not considered, Fin Curl status = 1).

Release	Type	Start Date	End Date	Age at int.		Ppn. Still Alive	Interval (SE)	N at End	(95% CI for N at Inteval End)		
				start (mos.)	end (mos.)						
6	SUM	09/23/05	04/29/06	13.9	21.1	0.39	0.06	67	48	to	87
6	SUM	04/29/06	07/13/06	21.1	23.6	0.29	0.05	51	33	to	69
6	SUM	07/13/06	09/27/06	23.6	26.2	0.22	0.05	39	23	to	56
6	SUM	09/27/06	05/02/07	26.2	33.4	0.11	0.03	19	8	to	31
6	SUM	05/02/07	09/22/07	33.4	38.2	0.07	0.03	13	4	to	22
6	SUM	09/22/07	04/30/08	38.2	45.5	0.04	0.02	8	2	to	14
6	SUM	04/30/08	07/22/08	45.5	48.3	0.04	0.02	6	1	to	12
6	SUM	07/22/08	09/16/08	48.3	50.2	0.03	0.01	6	1	to	11
6	SUM	09/16/08	05/08/09	50.2	58.0	0.02	0.01	3	0	to	7
6	SUM	05/08/09	07/22/09	58.0	60.5	0.02	0.01	3	0	to	6
6	SUM	07/22/09	09/15/09	60.5	62.3	0.02	0.01	3	0	to	6
6	SUM	09/15/09	05/04/10	62.3	70.0	0.01	0.01	2	0	to	4
6	SUM	05/04/10	09/08/10	70.0	74.2	0.01	0.01	2	0	to	3

Tag-loss adjusted estimates of survival for the 7th release cohort of summer yearlings in RPMA 2 (cohort= 1,363 fish, 67% released in Missouri, IV status not considered, Fin Curl status = 0).

Release	Type	Start Date	End Date	Age at int.		Ppn. Still Alive	Interval (SE)	N at End	(95% CI for N at Inteval End)		
				start (mos.)	end (mos.)				to	End	
7	SUM	07/13/06	09/27/06	13.9	16.4	0.88	0.02	1,199	1,152	to	1,247
7	SUM	09/27/06	05/02/07	16.4	23.6	0.63	0.04	853	737	to	970
7	SUM	05/02/07	09/22/07	23.6	28.4	0.52	0.05	711	586	to	836
7	SUM	09/22/07	04/30/08	28.4	35.8	0.41	0.05	557	436	to	679
7	SUM	04/30/08	07/22/08	35.8	38.5	0.38	0.04	519	402	to	635
7	SUM	07/22/08	09/16/08	38.5	40.4	0.36	0.04	496	383	to	610
7	SUM	09/16/08	05/08/09	40.4	48.2	0.31	0.04	417	316	to	518
7	SUM	05/08/09	07/22/09	48.2	50.7	0.29	0.04	400	303	to	498
7	SUM	07/22/09	09/15/09	50.7	52.5	0.28	0.03	381	288	to	473
7	SUM	09/15/09	05/04/10	52.5	60.2	0.23	0.03	311	234	to	388
7	SUM	05/04/10	09/08/10	60.2	64.5	0.21	0.03	283	213	to	354

Tag-loss adjusted estimates of survival for the 8th release cohort of summer yearlings in RPMA 2 (cohort= 3,260 fish, 21% released in Missouri, IV status not considered, Fin Curl status = 0).

Release	Type	Start Date	End Date	Age at int.		Ppn. Still Alive	Interval (SE)	N at End	(95% CI for N at Inteval End)		
				start (mos.)	end (mos.)				to	End	
8	SUM	07/22/08	09/16/08	13.9	15.7	0.92	0.01	3,003	2,924	to	3,081
8	SUM	09/16/08	05/08/09	15.7	23.5	0.67	0.04	2,169	1,902	to	2,437
8	SUM	05/08/09	07/22/09	23.5	26.0	0.61	0.04	1,998	1,714	to	2,281
8	SUM	07/22/09	09/15/09	26.0	27.9	0.58	0.05	1,889	1,600	to	2,178
8	SUM	09/15/09	05/04/10	27.9	35.6	0.46	0.05	1,514	1,220	to	1,809
8	SUM	05/04/10	09/08/10	35.6	39.8	0.42	0.04	1,379	1,095	to	1,662

Tag-loss adjusted estimates of survival for the 9th release cohort of summer yearlings in RPMA 2 (cohort= 3,780 fish, 53% released in Missouri, IV status not considered, Fin Curl status = 0).

Release	Type	Start Date	End Date	Age at int.		Ppn. Still Alive	Interval (SE)	N at End	(95% CI for N at Inteval End)		
				start (mos.)	end (mos.)				to	End	
9	SUM	07/22/09	09/15/09	13.9	15.7	0.92	0.01	3,459	3,364	to	3,554
9	SUM	09/15/09	05/04/10	15.7	23.4	0.64	0.04	2,427	2,109	to	2,744
9	SUM	05/04/10	09/08/10	23.4	27.6	0.55	0.05	2,077	1,735	to	2,419

When the most recent estimates of the proportion surviving and the number surviving from each release cohort are assembled, one can review how many fish released as summer yearlings are estimated to still be alive. The *unadjusted* point estimates indicated that ~3,547 fish of different ages were still alive in RPMA 2 at the time of the most recent survey used here (09/08/2010), that ~76% of those are ≤ 3.5 years old, ~23% were 5- to 9-years old, ~20% were ≥ 6 years old, and ~2% were > 10 years old. The *tag-loss adjusted estimates* indicate that ~4,536 fish of different ages were still alive in RPMA 2 at the time of the most recent survey used here (09/08/2010), that ~76% of those are ≤ 3.5 years old, ~23% were 5- to 9-years old, ~18% were ≥ 6 years old, and ~1% (56) were > 10 years old.

Tag-loss adjusted estimates of surviving proportions and numbers for summer yearlings released in RPMA 2.

Release	Type	Date	Age in months	Age in years	Ppn. Still Alive	(SE)	N Alive	(95% CI for N Alive)		
1: 789	SUM	09/08/10	160.9	13.4	0.04	0.01	31	17	to	45
2: 478	SUM	09/08/10	134.4	11.2	0.05	0.01	25	15	to	35
3: 3,089	SUM	09/08/10	112.0	9.3	0.06	0.01	190	115	to	266
4: 4,010	SUM	09/08/10	99.9	8.3	0.08	0.01	309	203	to	414
5: 1,586	SUM	09/08/10	86.5	7.2	0.15	0.02	240	170	to	310
6: 175	SUM	09/08/10	74.2	6.2	0.01	0.01	2	0	to	3
7: 1,363	SUM	09/08/10	64.5	5.4	0.21	0.03	283	213	to	354
8: 3,260	SUM	09/08/10	39.8	3.3	0.42	0.04	1,379	1,095	to	1,662
9: 3,780	SUM	09/08/10	27.6	2.3	0.55	0.05	2,077	1,735	to	2,419

Summary of tag-loss adjusted estimates of number alive as of 09/08/2010 across all releases of fish in RPMA 2. The previous reports did not provide such information and so such information is new for these analyses. Accordingly, comparisons with previous results cannot be made and will not appear for any RPMA.

Release*	Type	Date	Age in years	N Alive	(95% CI for N Alive)		
6: 40,948	FNG	09/08/10	1.2	28,474	24,551	to	32,396
6: 4,882	SPR	09/08/10	2.2	1,722	1,401	to	2,042
5: 58,838	FNG	09/08/10	2.2	28,138	20,835	to	35,442
9: 3,780	SUM	09/08/10	2.3	2,077	1,735	to	2,419
5: 8,005	SPR	09/08/10	3.2	1,387	996	to	1,778
4: 41,469	FNG	09/08/10	3.2	17,648	12,476	to	22,820
8: 3,260	SUM	09/08/10	3.3	1,379	1,095	to	1,662
4: 3,951	SPR	09/08/10	4.2	841	605	to	1,076
3: 6,916	FNG	09/08/10	4.2	2,386	1,529	to	3,243
3: 6,671	SPR	09/08/10	5.2	487	268	to	706
2: 12,469	FNG	09/08/10	5.3	3,180	1,728	to	4,632
7: 1,363	SUM	09/08/10	5.4	283	213	to	354
6: 175	SUM	09/08/10	6.2	31	17	to	45
2: 870	SPR	09/08/10	6.2	96	53	to	140
1: 16,810	FNG	09/08/10	6.3	35	0	to	95
5: 1,586	SUM	09/08/10	7.2	2	0	to	3
1: 821	SPR	09/08/10	7.3	114	57	to	171
4: 4,010	SUM	09/08/10	8.3	240	170	to	310
3: 3,089	SUM	09/08/10	9.3	309	203	to	414
2: 478	SUM	09/08/10	11.2	25	15	to	35
1: 789	SUM	09/08/10	13.4	190	115	to	266

*The Release column represents (a) the release cohort for the specific type of release and (b) the number of individuals in that release cohort.

When summarized by age class, the *tag-loss-adjusted* estimates indicate that 89,044 of the fish that were released from hatcheries in recent years in RPMA 2 were still alive there in September of 2010. The majority of these fish were estimated to be in the younger classes: ~68% were estimated to be in the 1- to 2-yr-old class, ~31% were in the 3- to 5-year-old class, ~1% were 6- to 9-years old, and <0.1% were ≥11 years old.

RPMA	Date	Age in years	N Alive	(Sum of 95% CI elements for N Alive)		
2	09/08/10	1 to 2	60,411	48,522	to	72,299
2	09/08/10	3 to 5	27,591	18,910	to	36,271
2	09/08/10	6 to 9	827	500	to	1,178
2	09/08/10	>11	215	130	to	301

RPMA 3

For RPMA 3, the top model of the mark-recapture data included the following covariates of survival: release type (categorized as spring yearlings, summer yearlings, or fish aged 2 or 3 years of age at time of release), age of fish, the proportion of the survival period that was in winter versus summer, and interactions between release type and age of fish. The model of capture probability included release fish age and capture session (different capture probabilities for different occasions).

For RPMA 3, neither diseases status nor river of release covariates were included in the model used to estimate survival rates. Thus, results are simply provided for each release cohort from time of release to the most recent date used in these analyses. The results below are for the release of 3,812 spring yearlings, 2,088 summer yearlings, 103 2-year-olds, and 650 3-year-olds (total = 7,553 fish).

Dates and numbers for releases and recapture work on RPMA 3.

Occ	Begin	End	Midpoint	Release Numbers for Each Fish Type								
				Spring		Summer		TwoYr		ThreeYr		
1	06/06/00	09/20/00	07/29/00						1	103	1	460
2	04/21/02	04/27/02	04/24/02	1	564						2	190
3	04/10/03	05/07/03	04/23/03									
4	07/26/03	07/26/03	07/26/03			1	607					
5	08/14/03	11/18/03	10/01/03									
6	04/15/04	05/19/04	05/02/04									
7	10/06/04	11/01/04	10/19/04			2	511					
8	03/13/05	05/26/05	04/19/05									
9	08/30/05	11/08/05	10/04/05			3	865					
10	03/30/06	05/17/06	04/23/06									
11	08/25/06	11/14/06	10/04/06			4	1,005					
12	04/01/07	05/09/07	04/20/07	2	600							
13	08/15/07	11/01/07	09/23/07									
14	04/08/08	05/15/08	04/26/08	3	1,169							
15	08/26/08	11/04/08	09/30/08									
16	04/08/09	05/29/09	05/03/09	4	637							
17	08/03/09	08/19/09	08/11/09									
18	04/11/10	06/15/10	05/13/10	5	842							
19	08/02/10	08/22/10	08/12/10									

Results for Releases of Spring Yearlings in RPMA 3

Data on the number of spring yearlings released on each occasion ($R(i)$) along with information on when they were 1st subsequently recaptured (on occasion j) is provided in the table below. At the time of the analyses presented here, 3,896 releases and re-releases of fish originally released as spring yearlings had been conducted, which resulted in 86 recaptures. The results presented below are based on the analyses of those 86 recaptures from 3,896 releases and re-releases.

Occ.	R(i)	j= 2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	Total
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	564		0	0	2	1	0	0	1	2	1	2	2	4	2	7	0	10	0	34
3	0			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	2					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	1						0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0							0	0	0	0	0	0	0	0	0	0	0	0	0
8	0								0	0	0	0	0	0	0	0	0	0	0	0
9	1									0	0	0	0	0	0	0	0	0	0	0
10	2										0	0	0	0	0	0	0	0	0	0
11	1											0	0	0	0	0	0	1	0	1
12	602												8	1	0	2	3	6	2	22
13	10													0	1	1	0	0	0	2
14	1174														4	4	3	8	0	19
15	7															0	0	0	0	0
16	651																3	5	0	8
17	9																	0	0	0
18	872																		0	0

Estimates of survival for the 1st release cohort of spring yearlings (~9.6 months old at time of release) in RPMA 3. *The estimates presented here indicate that survival is modest in the 1st year in the river and then that survival is 1.0 thereafter. This contrasts with previous estimates that indicated that survival early in life was very high and then more moderate in later years. The data on recoveries remains relatively sparse for this group and it is thus not surprising that details of results might change as data are added over time. Regardless, the current estimates still indicate that ~17% of a release cohort remains alive by the time the fish are 6- to 8-years old, which is quite similar to what was reported previously. Thus, it seems that perhaps what is changing most in results is the estimated details in how the survival rates change with age in this group.*

Start Date	End Date	Months	Age at int. start (mos.)	Age at int end (mos.)	Monthly Survival	(SE)	Ppn. Still Alive	(SE)	(95% CI for Cum. Ppn. Surviving)		
04/24/02	04/23/03	12.1	9.5	21.6	0.865	(0.015)	0.17	(0.04)	(0.10	to	0.24)
04/23/03	07/26/03	3.1	21.6	24.8	1.000	(0.000)	0.17	(0.04)	(0.10	to	0.24)
07/26/03	10/01/03	2.2	24.8	27.0	1.000	(0.000)	0.17	(0.04)	(0.10	to	0.24)
10/01/03	05/02/04	7.1	27.0	34.1	1.000	(0.001)	0.17	(0.04)	(0.10	to	0.24)
05/02/04	10/19/04	5.7	34.1	39.8	1.000	(0.000)	0.17	(0.04)	(0.10	to	0.24)
10/19/04	04/19/05	6.1	39.8	45.9	1.000	(0.000)	0.17	(0.04)	(0.10	to	0.24)
04/19/05	10/04/05	5.6	45.9	51.5	1.000	(0.000)	0.17	(0.04)	(0.10	to	0.24)
10/04/05	04/23/06	6.7	51.5	58.2	1.000	(0.000)	0.17	(0.04)	(0.10	to	0.24)
04/23/06	10/04/06	5.5	58.2	63.6	1.000	(0.000)	0.17	(0.04)	(0.10	to	0.24)
10/04/06	04/20/07	6.6	63.6	70.2	1.000	(0.000)	0.17	(0.04)	(0.10	to	0.24)
04/20/07	09/23/07	5.2	70.2	75.4	1.000	(0.000)	0.17	(0.04)	(0.10	to	0.24)
09/23/07	04/26/08	7.2	75.4	82.6	1.000	(0.000)	0.17	(0.04)	(0.10	to	0.24)
04/26/08	09/30/08	5.2	82.6	87.9	1.000	(0.000)	0.17	(0.04)	(0.10	to	0.24)
09/30/08	05/03/09	7.2	87.9	95.0	1.000	(0.000)	0.17	(0.04)	(0.10	to	0.24)
05/03/09	08/11/09	3.3	95.0	98.4	1.000	(0.000)	0.17	(0.04)	(0.10	to	0.24)
08/11/09	05/13/10	9.2	98.4	107.5	1.000	(0.000)	0.17	(0.04)	(0.10	to	0.24)
05/13/10	08/12/10	3.0	107.5	110.6	1.000	(0.000)	0.17	(0.04)	(0.10	to	0.24)

Estimates of survival for the 1st release cohort of spring yearlings (~9.6 months old at time of release) in RPMA 3.

Release	Type	Start Date	End Date	Age at int. start (mos.)	Age at int end (mos.)	Ppn. Still Alive	(SE)	N at Interval End	(95% CI for N at Inteval End)		
1	SPR	04/24/02	04/23/03	9.5	21.6	0.17	0.04	97	56	to	138
1	SPR	04/23/03	07/26/03	21.6	24.8	0.17	0.04	97	56	to	138
1	SPR	07/26/03	10/01/03	24.8	27.0	0.17	0.04	97	56	to	138
1	SPR	10/01/03	05/02/04	27.0	34.1	0.17	0.04	96	55	to	137
1	SPR	05/02/04	10/19/04	34.1	39.8	0.17	0.04	96	55	to	137
1	SPR	10/19/04	04/19/05	39.8	45.9	0.17	0.04	96	55	to	137
1	SPR	04/19/05	10/04/05	45.9	51.5	0.17	0.04	96	55	to	137
1	SPR	10/04/05	04/23/06	51.5	58.2	0.17	0.04	96	55	to	137
1	SPR	04/23/06	10/04/06	58.2	63.6	0.17	0.04	96	55	to	137
1	SPR	10/04/06	04/20/07	63.6	70.2	0.17	0.04	96	55	to	137
1	SPR	04/20/07	09/23/07	70.2	75.4	0.17	0.04	96	55	to	137
1	SPR	09/23/07	04/26/08	75.4	82.6	0.17	0.04	96	55	to	137
1	SPR	04/26/08	09/30/08	82.6	87.9	0.17	0.04	96	55	to	137
1	SPR	09/30/08	05/03/09	87.9	95.0	0.17	0.04	96	55	to	137
1	SPR	05/03/09	08/11/09	95.0	98.4	0.17	0.04	96	55	to	137
1	SPR	08/11/09	05/13/10	98.4	107.5	0.17	0.04	96	55	to	137
1	SPR	05/13/10	08/12/10	107.5	110.6	0.17	0.04	96	55	to	137

Estimates of survival for the 2nd release cohort of spring yearlings (~9.6 months old at time of release) in RPMA 3.

Release	Type	Start Date	End Date	Age at int. start (mos.)	Age at int end (mos.)	Ppn. Still Alive	(SE)	N at Interval End	(95% CI for N at Inteval End)		
2	SPR	04/20/07	09/23/07	9.5	14.7	0.99	0.02	592	573	to	600
2	SPR	09/23/07	04/26/08	14.7	21.9	0.26	0.08	159	65	to	253
2	SPR	04/26/08	09/30/08	21.9	27.1	0.26	0.08	159	65	to	253
2	SPR	09/30/08	05/03/09	27.1	34.3	0.26	0.08	159	64	to	253
2	SPR	05/03/09	08/11/09	34.3	37.6	0.26	0.08	159	64	to	253
2	SPR	08/11/09	05/13/10	37.6	46.8	0.26	0.08	159	64	to	253
2	SPR	05/13/10	08/12/10	46.8	49.8	0.26	0.08	159	64	to	253

Estimates of survival for the 3rd release cohort of spring yearlings (~9.6 months old at time of release) in RPMA 3.

Release	Type	Start Date	End Date	Age at int. start (mos.)	Age at int end (mos.)	Ppn. Still Alive	(SE)	N at Interval End	(95% CI for N at Inteval End)		
3	SPR	04/26/08	09/30/08	9.5	14.7	0.99	0.02	1,152	1,116	to	1,169
3	SPR	09/30/08	05/03/09	14.7	21.9	0.27	0.08	317	132	to	502
3	SPR	05/03/09	08/11/09	21.9	25.2	0.27	0.08	317	132	to	502
3	SPR	08/11/09	05/13/10	25.2	34.4	0.27	0.08	316	131	to	501
3	SPR	05/13/10	08/12/10	34.4	37.4	0.27	0.08	316	131	to	501

Estimates of survival for the 4th release cohort of spring yearlings (~9.6 months old at time of release) in RPMA 3.

Release	Type	Start Date	End Date	Age at int. start (mos.)	Age at int end (mos.)	Ppn. Still Alive	(SE)	N at Interval End	(95% CI for N at Inteval End)		
4	SPR	05/03/09	08/11/09	9.5	12.8	0.99	0.01	631	619	to	637
4	SPR	08/11/09	05/13/10	12.8	22.0	0.36	0.07	227	138	to	315
4	SPR	05/13/10	08/12/10	22.0	25.0	0.36	0.07	227	138	to	315

Summary information for spring yearlings released in RPMA 3.

When the most recent estimates of the proportion surviving and the number surviving from each release cohort are assembled, one can review how many fish released as spring yearlings were estimated to still be alive as of the last date analyzed here. The point estimates indicate that 789 of these fish were still alive in RPMA 3 as of 08/12/10. Of these ~88% (~702) were \leq ~4 years old, and the remainder were ~9 years old.

Estimates of surviving proportions and numbers for spring yearling releases in RPMA 3.

Release	Type	Date	Age in months	Age in years	Ppn. Still Alive	(SE)	N Alive	(95% CI for N Alive)		
1: 564	SPR	08/12/10	107.5	9.0	0.17	0.04	96	55	to	137
2: 600	SPR	08/12/10	46.8	3.9	0.26	0.08	159	64	to	253
3: 1,169	SPR	08/12/10	34.4	2.9	0.27	0.08	316	131	to	501
4: 637	SPR	08/12/10	22.0	1.8	0.36	0.07	227	138	to	315

Results for Releases of Summer Yearlings in RPMA 3

Data on the number of summer yearlings released on each occasion ($R(i)$) along with information on when they were 1st subsequently recaptured (on occasion j) is provided in the table below. At the time of the analyses presented here, 3,218 releases and re-releases of fish originally released as summer yearlings had been conducted, which resulted in 236 recaptures. The results presented below are based on the analyses of the data collected on those released and recaptured fish.

Occ.	R(i)	j= 2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	Total
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	I		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	607			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	1				1	1	3	1	4	3	3	7	3	4	11	9	0	8	0	58
6	1					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	514						0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	1							0	5	0	1	8	3	7	5	9	0	6	0	44
9	874								0	0	0	0	0	0	0	0	0	0	0	0
10	6									3	1	1	8	4	4	19	2	15	1	58
11	1010										0	0	0	0	0	0	0	0	0	0
12	16											0	5	6	5	9	3	18	5	51
13	19												0	0	0	1	0	2	0	3
14	22													1	2	0	0	2	0	5
15	28														1	2	0	1	0	4
16	50															1	0	4	0	5
17	6																1	7	0	8
18	63																	0	0	0
																			0	0

Estimates of survival for the 1st release cohort of summer yearlings (~14.2 months old at time of release) in RPMA 3. *Estimates for this release type did not change substantially from the previous report's estimates. However, the precision here is markedly better than previous estimates, which is not surprising given the change in the total number of recaptures has continued to grow over time.*

Start Date	End Date	Months	Age at int. start (mos.)	Age at int end (mos.)	Monthly Survival	(SE)	Ppn. Still Alive	(SE)	(95% CI for Cum. Ppn. Surviving)
07/26/03	10/01/03	2.2	14.2	16.5	1.000	(0.000)	1.00	(0.00)	(1.00 to 1.00)
10/01/03	05/02/04	7.1	16.5	23.6	0.967	(0.012)	0.79	(0.07)	(0.65 to 0.93)
05/02/04	10/19/04	5.7	23.6	29.3	1.000	(0.000)	0.79	(0.07)	(0.65 to 0.93)
10/19/04	04/19/05	6.1	29.3	35.3	0.958	(0.009)	0.61	(0.09)	(0.44 to 0.78)
04/19/05	10/04/05	5.6	35.3	40.9	1.000	(0.000)	0.61	(0.09)	(0.44 to 0.78)
10/04/05	04/23/06	6.7	40.9	47.6	0.964	(0.006)	0.47	(0.08)	(0.33 to 0.62)
04/23/06	10/04/06	5.5	47.6	53.1	1.000	(0.000)	0.47	(0.08)	(0.33 to 0.62)
10/04/06	04/20/07	6.6	53.1	59.7	0.963	(0.010)	0.37	(0.06)	(0.25 to 0.49)
04/20/07	09/23/07	5.2	59.7	64.9	1.000	(0.000)	0.37	(0.06)	(0.25 to 0.49)
09/23/07	04/26/08	7.2	64.9	72.1	0.977	(0.010)	0.31	(0.06)	(0.20 to 0.42)
04/26/08	09/30/08	5.2	72.1	77.3	1.000	(0.000)	0.31	(0.06)	(0.20 to 0.42)
09/30/08	05/03/09	7.2	77.3	84.5	0.979	(0.014)	0.27	(0.06)	(0.15 to 0.39)
05/03/09	08/11/09	3.3	84.5	87.8	1.000	(0.000)	0.27	(0.06)	(0.15 to 0.39)
08/11/09	05/13/10	9.2	87.8	97.0	0.995	(0.005)	0.26	(0.07)	(0.13 to 0.39)
05/13/10	08/12/10	3.0	97.0	100.0	1.000	(0.000)	0.26	(0.07)	(0.13 to 0.39)

Estimates of survival for the 1st release cohort of summer yearlings (~14.2 months old at time of release) in RPMA 3.

Release	Type	Start Date	End Date	Age at int. start (mos.)	Age at int end (mos.)	Ppn. Still Alive	(SE)	N at Interval End	(95% CI for N at Inteval End)		
1	SUM	07/26/03	10/01/03	14.2	16.5	1.00	0.00	607	607	to	607
1	SUM	10/01/03	05/02/04	16.5	23.6	0.79	0.07	478	394	to	563
1	SUM	05/02/04	10/19/04	23.6	29.3	0.79	0.07	478	393	to	563
1	SUM	10/19/04	04/19/05	29.3	35.3	0.61	0.09	369	266	to	472
1	SUM	04/19/05	10/04/05	35.3	40.9	0.61	0.09	369	266	to	472
1	SUM	10/04/05	04/23/06	40.9	47.6	0.47	0.08	288	198	to	378
1	SUM	04/23/06	10/04/06	47.6	53.1	0.47	0.08	288	198	to	378
1	SUM	10/04/06	04/20/07	53.1	59.7	0.37	0.06	225	153	to	297
1	SUM	04/20/07	09/23/07	59.7	64.9	0.37	0.06	225	153	to	297
1	SUM	09/23/07	04/26/08	64.9	72.1	0.31	0.06	190	124	to	257
1	SUM	04/26/08	09/30/08	72.1	77.3	0.31	0.06	190	124	to	257
1	SUM	09/30/08	05/03/09	77.3	84.5	0.27	0.06	163	89	to	237
1	SUM	05/03/09	08/11/09	84.5	87.8	0.27	0.06	163	89	to	237
1	SUM	08/11/09	05/13/10	87.8	97.0	0.26	0.07	156	77	to	235
1	SUM	05/13/10	08/12/10	97.0	100.0	0.26	0.07	156	77	to	235

Estimates of survival for the 2nd release cohort of summer yearlings (~14.2 months old at time of release) in RPMA 3.

Release	Type	Start Date	End Date	Age at int. start (mos.)	Age at int end (mos.)	Ppn. Still Alive	(SE)	N at Interval End	(95% CI for N at Inteval End)		
2	SUM	10/19/04	04/19/05	14.2	20.3	0.75	0.09	385	297	to	474
2	SUM	04/19/05	10/04/05	20.3	25.9	0.75	0.09	385	297	to	474
2	SUM	10/04/05	04/23/06	25.9	32.6	0.58	0.11	294	188	to	400
2	SUM	04/23/06	10/04/06	32.6	38.1	0.58	0.11	294	188	to	400
2	SUM	10/04/06	04/20/07	38.1	44.7	0.44	0.09	225	133	to	317
2	SUM	04/20/07	09/23/07	44.7	49.9	0.44	0.09	225	133	to	317
2	SUM	09/23/07	04/26/08	49.9	57.1	0.37	0.07	187	113	to	262
2	SUM	04/26/08	09/30/08	57.1	62.3	0.37	0.07	187	113	to	262
2	SUM	09/30/08	05/03/09	62.3	69.5	0.31	0.06	158	99	to	217
2	SUM	05/03/09	08/11/09	69.5	72.8	0.31	0.06	158	99	to	217
2	SUM	08/11/09	05/13/10	72.8	82.0	0.29	0.06	151	94	to	208
2	SUM	05/13/10	08/12/10	82.0	85.0	0.29	0.06	151	94	to	208

Estimates of survival for the 3rd release cohort of summer yearlings (~14.2 months old at time of release) in RPMA 3.

Release	Type	Start Date	End Date	Age at int. start (mos.)	Age at int end (mos.)	Ppn. Still Alive	(SE)	N at Interval End	(95% CI for N at Interval End)		
3	SUM	10/04/05	04/23/06	14.2	20.9	0.75	0.09	648	498	<i>to</i>	799
3	SUM	04/23/06	10/04/06	20.9	26.4	0.75	0.09	648	497	<i>to</i>	799
3	SUM	10/04/06	04/20/07	26.4	33.0	0.56	0.11	487	307	<i>to</i>	666
3	SUM	04/20/07	09/23/07	33.0	38.2	0.56	0.11	487	307	<i>to</i>	666
3	SUM	09/23/07	04/26/08	38.2	45.4	0.46	0.09	400	241	<i>to</i>	559
3	SUM	04/26/08	09/30/08	45.4	50.6	0.46	0.09	400	241	<i>to</i>	559
3	SUM	09/30/08	05/03/09	50.6	57.8	0.39	0.08	333	206	<i>to</i>	461
3	SUM	05/03/09	08/11/09	57.8	61.1	0.39	0.08	333	205	<i>to</i>	461
3	SUM	08/11/09	05/13/10	61.1	70.3	0.37	0.07	317	197	<i>to</i>	436
3	SUM	05/13/10	08/12/10	70.3	73.3	0.37	0.07	317	197	<i>to</i>	436

Estimates of survival for the 4th release cohort of summer yearlings (~14.2 months old at time of release) in RPMA 3.

Release	Type	Start Date	End Date	Age at int. start (mos.)	Age at int end (mos.)	Ppn. Still Alive	(SE)	N at Interval End	(95% CI for N at Interval End)		
4	SUM	10/04/06	04/20/07	14.2	20.8	0.74	0.09	739	554	<i>to</i>	924
4	SUM	04/20/07	09/23/07	20.8	26.0	0.74	0.09	739	554	<i>to</i>	924
4	SUM	09/23/07	04/26/08	26.0	33.2	0.60	0.11	599	391	<i>to</i>	806
4	SUM	04/26/08	09/30/08	33.2	38.5	0.60	0.11	599	391	<i>to</i>	806
4	SUM	09/30/08	05/03/09	38.5	45.6	0.49	0.09	493	307	<i>to</i>	678
4	SUM	05/03/09	08/11/09	45.6	49.0	0.49	0.09	493	307	<i>to</i>	678
4	SUM	08/11/09	05/13/10	49.0	58.1	0.46	0.09	466	291	<i>to</i>	642
4	SUM	05/13/10	08/12/10	58.1	61.2	0.46	0.09	466	291	<i>to</i>	641

Summary information for summer yearlings released in RPMA 3.

When the most recent estimates of the proportion surviving and the number surviving from each release cohort are assembled, one can review how many fish released as summer yearlings are estimated to still be alive. The point estimates indicate that 1,090 of these fish were still alive in RPMA 3 as of the last date analyzed here. Of these ~57% (~624) were \geq ~6 years old.

Estimates of surviving proportions and numbers for summer yearling releases in RPMA 3.

Release	Type	Date	Age in months	Age in years	Ppn. Still Alive	(SE)	N Alive	(95% CI for N Alive)		
1: 607	SUM	08/12/10	97.0	8.1	100.0	0.26	156	77	<i>to</i>	235
2: 511	SUM	08/12/10	82.0	6.8	85.0	0.29	151	94	<i>to</i>	208
3: 865	SUM	08/12/10	70.3	5.9	73.3	0.37	317	197	<i>to</i>	436
4: 1,005	SUM	08/12/10	58.1	4.8	61.20	0.46	466	291	<i>to</i>	641

Results for Releases of Two-Year Olds in RPMA 3

Data on the number of two-year-olds released on each occasion ($R(i)$) along with information on when they were 1st subsequently recaptured (on occasion j) is provided in the table below. At the time of the analyses presented here, 112 releases and re-releases of fish of this this release type had been achieved, which resulted in 9 recaptures. The results presented below are based on the analyses of the data collected on those released and recaptured fish.

Occ.	R(i)	j= 2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	Total
1	103	0	0	0	1	1	1	0	1	0	0	1	0	0	1	1	0	1	0	8
2	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	1					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	1						0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	1							0	0	0	0	0	0	0	0	0	0	0	0	0
8	0								0	0	0	0	0	0	0	0	0	0	0	0
9	1									0	0	0	0	0	0	0	0	0	0	0
10	0										0	0	0	0	0	0	0	0	0	0
11	0											0	0	0	0	0	0	0	0	0
12	1												0	0	0	0	0	0	0	0
13	0													0	0	0	0	0	0	0
14	0														0	0	0	0	0	0
15	1															0	0	0	0	0
16	1																1	0	0	1
17	1																	0	0	0
18	1																		0	0

Estimates of survival for the 1st (& only) release cohort of two-year olds (~27.7 months old at time of release) in RPMA 3. *Estimates of the proportion still alive remain low for this release type. However, the point estimates are a bit higher in this report than in the previous one and the estimates of precision are somewhat improved. The estimates continue to be based on modest numbers of recaptures.*

Start Date	End Date	Months	Age at int. start (mos.)	Age at int end (mos.)	Monthly Survival	(SE)	Ppn. Still Alive	(SE)	(95% CI for Cum. Ppn. Surviving)		
07/29/00	04/24/02	21.1	27.7	48.9	0.984	(0.010)	0.72	(0.15)	0.42	to	1.00
04/24/02	04/23/03	12.1	48.9	61	0.994	(0.004)	0.67	(0.17)	0.33	to	1.00
04/23/03	07/26/03	3.1	61	64.1	1.000	(0.000)	0.67	(0.17)	0.33	to	1.00
07/26/03	10/01/03	2.2	64.1	66.4	1.000	(0.000)	0.67	(0.17)	0.33	to	1.00
10/01/03	05/02/04	7.1	66.3	73.5	0.919	(0.013)	0.36	(0.11)	0.15	to	0.58
05/02/04	10/19/04	5.7	73.5	79.2	1.000	(0.000)	0.36	(0.11)	0.15	to	0.58
10/19/04	04/19/05	6.1	79.2	85.2	0.908	(0.014)	0.20	(0.06)	0.08	to	0.32
04/19/05	10/04/05	5.6	85.2	90.8	1.000	(0.000)	0.20	(0.06)	0.08	to	0.32
10/04/05	04/23/06	6.7	90.8	97.5	0.927	(0.009)	0.12	(0.04)	0.05	to	0.19
04/23/06	10/04/06	5.5	97.5	103	1.000	(0.000)	0.12	(0.04)	0.05	to	0.19
10/04/06	04/20/07	6.6	103	109.6	0.933	(0.012)	0.08	(0.02)	0.04	to	0.12
04/20/07	09/23/07	5.2	109.6	114.8	1.000	(0.000)	0.08	(0.02)	0.04	to	0.12
09/23/07	04/26/08	7.2	114.8	122	0.961	(0.009)	0.06	(0.02)	0.03	to	0.09
04/26/08	09/30/08	5.2	122	127.2	1.000	(0.000)	0.06	(0.02)	0.03	to	0.09
09/30/08	05/03/09	7.2	127.2	134.4	0.967	(0.011)	0.05	(0.01)	0.02	to	0.07
05/03/09	08/11/09	3.3	134.4	137.7	1.000	(0.000)	0.05	(0.01)	0.02	to	0.07
08/11/09	05/13/10	9.2	137.7	146.9	0.993	(0.004)	0.04	(0.01)	0.02	to	0.07
05/13/10	08/12/10	3	146.9	149.9	1.000	(0.000)	0.04	(0.01)	0.02	to	0.07

Estimates of survival for the 1st release cohort of two-year olds (~27.7 months old at time of release) in RPMA 3.

Release	Type	Start Date	End Date	Age at int. start (mos.)	Age at int end (mos.)	Ppn. Still Alive	(SE)	N at Interval End	(95% CI for N at Inteval End)		
1	Two	07/29/00	04/24/02	27.7	48.9	0.72	0.15	74	44	to	103
1	Two	04/24/02	04/23/03	48.9	61.0	0.67	0.17	69	34	to	103
1	Two	04/23/03	07/26/03	61.0	64.1	0.67	0.17	69	34	to	103
1	Two	07/26/03	10/01/03	64.1	66.4	0.67	0.17	69	34	to	103
1	Two	10/01/03	05/02/04	66.3	73.5	0.36	0.11	38	16	to	59
1	Two	05/02/04	10/19/04	73.5	79.2	0.36	0.11	38	16	to	59
1	Two	10/19/04	04/19/05	79.2	85.2	0.20	0.06	21	9	to	33
1	Two	04/19/05	10/04/05	85.2	90.8	0.20	0.06	21	9	to	33
1	Two	10/04/05	04/23/06	90.8	97.5	0.12	0.04	13	5	to	20
1	Two	04/23/06	10/04/06	97.5	103.0	0.12	0.04	13	5	to	20
1	Two	10/04/06	04/20/07	103.0	109.6	0.08	0.02	8	4	to	12
1	Two	04/20/07	09/23/07	109.6	114.8	0.08	0.02	8	4	to	12
1	Two	09/23/07	04/26/08	114.8	122.0	0.06	0.02	6	3	to	9
1	Two	04/26/08	09/30/08	122.0	127.2	0.06	0.02	6	3	to	9
1	Two	09/30/08	05/03/09	127.2	134.4	0.05	0.01	5	2	to	7
1	Two	05/03/09	08/11/09	134.4	137.7	0.05	0.01	5	2	to	7
1	Two	08/11/09	05/13/10	137.7	146.9	0.04	0.01	4	2	to	7
1	Two	05/13/10	08/12/10	146.9	149.9	0.04	0.01	4	2	to	7

Summary information for fish released as 2-year-olds in RPMA 3.

Based on the most recent estimates of the proportion surviving and the number surviving from the single release cohort, 4 fish were estimated to still be alive in RPMA 3 as of 08/12/2010. These fish were ~12.5 years old at that time.

Release	Type	Date	Age in months	Age in years	Ppn. Still Alive	(SE)	N Alive	(95% CI for N Alive)		
1: 103	Two	08/12/10	149.9	12.5	0.04	(0.01)	4	2	to	7

Results for Releases of Three-Year Olds in RPMA 3

Data on the number of three-year-olds released on each occasion ($R(i)$) along with information on when they were 1st subsequently recaptured (on occasion j) is provided in the table below. At the time of the analyses presented here, 720 releases and re-releases of fish in this release type had been achieved, which resulted in 71 recaptures. The results presented below are based on the analyses of the data collected on those released and recaptured fish.

Occ.	R(i)	j= 2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	Total
1	460	0	3	0	8	5	0	1	2	0	2	2	4	2	5	5	2	3	0	44
2	190		2	0	5	2	1	1	0	0	1	0	0	0	1	2	0	0	0	15
3	5			0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1
4	0				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	13					0	0	1	0	0	0	0	0	0	0	0	0	0	0	1
6	7						0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	1							0	0	0	0	0	0	0	0	0	0	0	0	0
8	3								0	0	1	0	0	0	0	0	0	0	0	1
9	2									0	0	0	0	0	0	0	0	0	0	0
10	0										0	0	0	0	0	0	0	0	0	0
11	4											0	0	0	0	1	0	0	0	1
12	2												0	0	0	0	0	0	0	0
13	4													0	1	0	0	0	0	1
14	2														0	0	0	1	0	1
15	7															3	0	1	0	4
16	12																0	0	1	1
17	2																	1	0	1
18	6																		0	0

Estimates of survival for the 1st release cohort of three-year olds (~36.3 months old at time of release) in RPMA 3. *Estimates of the proportion still alive remain low for this release type. However, the point estimates are a bit lower in this report than in the previous one and the estimates of precision are improved. The estimates continue to be based on modest numbers of recaptures.*

Start Date	End Date	Months	Age at int. start (mos.)	Age at int end (mos.)	Monthly Survival	(SE)	Ppn. Still Alive	(SE)	(95% CI for Cum. Ppn. Surviving)	
07/29/00	04/24/02	21.1	36.3	57.4	0.986	(0.008)	0.74	(0.13)	0.49	to 1.00
04/24/02	04/23/03	12.1	57.4	69.5	0.995	(0.004)	0.70	(0.15)	0.39	to 1.00
04/23/03	07/26/03	3.1	69.5	72.7	1.000	(0.000)	0.70	(0.16)	0.39	to 1.00
07/26/03	10/01/03	2.2	72.7	74.9	1.000	(0.000)	0.70	(0.16)	0.39	to 1.00
10/01/03	05/02/04	7.1	74.9	82	0.928	(0.008)	0.41	(0.09)	0.22	to 0.59
05/02/04	10/19/04	5.7	82	87.7	1.000	(0.000)	0.41	(0.10)	0.22	to 0.59
10/19/04	04/19/05	6.1	87.7	93.8	0.918	(0.012)	0.24	(0.05)	0.14	to 0.34
04/19/05	10/04/05	5.6	93.8	99.4	1.000	(0.000)	0.24	(0.05)	0.14	to 0.34
10/04/05	04/23/06	6.7	99.4	106.1	0.935	(0.010)	0.15	(0.03)	0.10	to 0.21
04/23/06	10/04/06	5.5	106.1	111.5	1.000	(0.000)	0.15	(0.03)	0.10	to 0.21
10/04/06	04/20/07	6.6	111.5	118.1	0.941	(0.013)	0.10	(0.02)	0.06	to 0.14
04/20/07	09/23/07	5.2	118.1	123.3	1.000	(0.000)	0.10	(0.02)	0.06	to 0.14
09/23/07	04/26/08	7.2	123.3	130.5	0.966	(0.010)	0.08	(0.02)	0.04	to 0.12
04/26/08	09/30/08	5.2	130.5	135.8	1.000	(0.000)	0.08	(0.02)	0.04	to 0.12
09/30/08	05/03/09	7.2	135.8	142.9	0.971	(0.011)	0.07	(0.02)	0.03	to 0.10
05/03/09	08/11/09	3.3	142.9	146.3	1.000	(0.000)	0.07	(0.02)	0.03	to 0.10
08/11/09	05/13/10	9.2	146.3	155.4	0.994	(0.004)	0.06	(0.02)	0.02	to 0.10
05/13/10	08/12/10	3	155.4	158.5	1.000	(0.000)	0.06	(0.02)	0.02	to 0.10

Estimates of survival for the 1st release cohort of three-year olds (~36.3 months old at time of release) in RPMA 3.

Release	Type	Start Date	End Date	Age at int. start (mos.)	Age at int end (mos.)	Ppn. Still Alive	(SE)	N at Interval End	(95% CI for N at Inteval End)		
1	Three	07/29/00	04/24/02	36.3	57.4	0.74	0.13	343	224	<i>to</i>	460
1	Three	04/24/02	04/23/03	57.4	69.5	0.70	0.15	321	181	<i>to</i>	460
1	Three	04/23/03	07/26/03	69.5	72.7	0.70	0.16	321	181	<i>to</i>	460
1	Three	07/26/03	10/01/03	72.7	74.9	0.70	0.16	321	181	<i>to</i>	460
1	Three	10/01/03	05/02/04	74.9	82.0	0.41	0.09	188	103	<i>to</i>	274
1	Three	05/02/04	10/19/04	82.0	87.7	0.41	0.1	188	102	<i>to</i>	274
1	Three	10/19/04	04/19/05	87.7	93.8	0.24	0.05	112	66	<i>to</i>	158
1	Three	04/19/05	10/04/05	93.8	99.4	0.24	0.05	112	66	<i>to</i>	158
1	Three	10/04/05	04/23/06	99.4	106.1	0.15	0.03	71	44	<i>to</i>	99
1	Three	04/23/06	10/04/06	106.1	111.5	0.15	0.03	71	44	<i>to</i>	99
1	Three	10/04/06	04/20/07	111.5	118.1	0.10	0.02	48	29	<i>to</i>	66
1	Three	04/20/07	09/23/07	118.1	123.3	0.10	0.02	48	29	<i>to</i>	66
1	Three	09/23/07	04/26/08	123.3	130.5	0.08	0.02	37	20	<i>to</i>	54
1	Three	04/26/08	09/30/08	130.5	135.8	0.08	0.02	37	20	<i>to</i>	54
1	Three	09/30/08	05/03/09	135.8	142.9	0.07	0.02	30	13	<i>to</i>	47
1	Three	05/03/09	08/11/09	142.9	146.3	0.07	0.02	30	13	<i>to</i>	47
1	Three	08/11/09	05/13/10	146.3	155.4	0.06	0.02	28	11	<i>to</i>	46
1	Three	05/13/10	08/12/10	155.4	158.5	0.06	0.02	28	11	<i>to</i>	46

Estimates of survival for the 2nd release cohort of three-year olds (~36.3 months old at time of release) in RPMA 3.

Release	Type	Start Date	End Date	Age at int. start (mos.)	Age at int end (mos.)	Ppn. Still Alive	(SE)	N at Interval End	(95% CI for N at Inteval End)		
2	Three	04/24/02	04/23/03	36.3	48.4	0.92	0.06	174	151	to	190
2	Three	04/23/03	07/26/03	48.4	51.5	0.91	0.06	174	151	to	190
2	Three	07/26/03	10/01/03	51.5	53.8	0.91	0.06	174	151	to	190
2	Three	10/01/03	05/02/04	53.8	60.9	0.45	0.09	85	52	to	118
2	Three	05/02/04	10/19/04	60.9	66.6	0.45	0.09	85	52	to	118
2	Three	10/19/04	04/19/05	66.6	72.6	0.22	0.07	42	16	to	69
2	Three	04/19/05	10/04/05	72.6	78.2	0.22	0.07	42	16	to	69
2	Three	10/04/05	04/23/06	78.2	84.9	0.12	0.05	23	5	to	41
2	Three	04/23/06	10/04/06	84.9	90.4	0.12	0.05	23	5	to	41
2	Three	10/04/06	04/20/07	90.4	97.0	0.07	0.03	13	2	to	25
2	Three	04/20/07	09/23/07	97.0	102.2	0.07	0.03	13	2	to	25
2	Three	09/23/07	04/26/08	102.2	109.4	0.05	0.02	10	2	to	17
2	Three	04/26/08	09/30/08	109.4	114.6	0.05	0.02	10	2	to	17
2	Three	09/30/08	05/03/09	114.6	121.8	0.04	0.01	7	2	to	13
2	Three	05/03/09	08/11/09	121.8	125.1	0.04	0.01	7	2	to	13
2	Three	08/11/09	05/13/10	125.1	134.3	0.04	0.01	7	2	to	12
2	Three	05/13/10	08/12/10	134.3	137.3	0.04	0.01	7	2	to	12

Summary information for fish released as 3-year-olds in RPMA 3.

Based on the most recent estimates of the proportion surviving and the number surviving from the 2 release cohorts for this group, 35 fish were estimated to still be alive in RPMA 3 as of 08/12/2010. Of these, 28 were ~13 years old and 7 were ~11.4 years old at that time.

Release	Type	Date	Age in months	Age in years	Ppn. Still Alive	(SE)	N Alive	(95% CI for N Alive)		
1: 460	Three	08/12/10	158.5	13.2	0.06	0.02	28	11	to	46
2: 190	Three	08/12/10	137.3	11.4	0.04	0.01	7	2	to	12

Summary of number alive as of 08/12/2010 across all releases of fish in RPMA 3. *The previous reports did not provide such information and so such information is new for these analyses. Accordingly, comparisons with previous results cannot be made and will not appear for any RPMA.*

Release*	Type	Date	Age in years	N Alive	(95% CI for N Alive)		
4: 637	SPR	08/12/10	1.8	227	138	to	315
3: 1,169	SPR	08/12/10	2.9	316	131	to	501
2: 600	SPR	08/12/10	3.9	159	64	to	253
4: 1,005	SUM	08/12/10	4.8	466	291	to	641
3: 865	SUM	08/12/10	5.9	317	197	to	436
2: 511	SUM	08/12/10	6.8	151	94	to	208
1: 607	SUM	08/12/10	8.1	156	77	to	235
1: 564	SPR	08/12/10	9.0	96	55	to	137
2: 190	Three	08/12/10	11.4	7	2	to	12
1: 103	Two	08/12/10	12.5	4	2	to	7
1: 460	Three	08/12/10	13.2	28	11	to	46

**The Release column represents (a) the release cohort for the specific type of release and (b) the number of individuals in that release cohort.*

When summarized by age class, the estimates indicate that ~1,927 of the fish that were released from hatcheries in recent years in RPMA 3 were still alive there in August of 2010. Of these fish, ~12% (or 227 fish) were estimated to be 1- to 2-years old, ~49% (or 941) were ~3- to 5-years old, ~37% (or 720) were ~6- to 9-years old, and ~2% (or 39) were older than 11-years old.

Date	Age in years	N Alive	(Sum of 95% CI elements for N Alive)		
08/12/10	1 to 2	227	138	to	315
08/12/10	3 to 5	941	486	to	1,395
08/12/10	6 to 9	720	423	to	1,016
08/12/10	>10	39	15	to	65

Summary of Estimated Numbers across RPMAs with estimates updated in Fall 2012 to account for changes in input data for RPMA 1 as well as trapping effort and loss of PIT tags in RPMA 2.

RPMA	Date	Age in years	N Alive	elements for N Alive)
1	09/08/10	1 to 2	2,849	2,049 to 3,650
1	09/08/10	3 to 5	5,809	4,074 to 7,544
1	09/08/10	6 to 9	255	144 to 368
1	09/08/10	>11	226	130 to 321

RPMA	Date	Age in years	N Alive	(Sum of 95% CI elements for N Alive)
2	09/08/10	1 to 2	60,411	48,522 to 72,299
2	09/08/10	3 to 5	27,591	18,910 to 36,271
2	09/08/10	6 to 9	827	500 to 1,178
2	09/08/10	>11	215	130 to 301

RPMA	Date	Age in years	N Alive	(Sum of 95% CI elements for N Alive)
3	08/12/10	1 to 2	227	138 to 315
3	08/12/10	3 to 5	941	486 to 1,395
3	08/12/10	6 to 9	720	423 to 1,016
3	08/12/10	>10	39	15 to 65

Conclusion

Addition of data from recent trapping occasions and years has added data for each RPMA and all stocking categories. Improvements in estimates and especially in precision are in keeping with where data improvements were greatest (i.e., not all release types on all RPMAs had the same percentage improvement in recaptures, and those that had the greatest improvements experienced the most substantial changes in precision).

The results provided here are the first estimates of actual proportions and total numbers projected to be still alive for actual release cohorts. Based on these estimates, it appears that substantial numbers of fish were still alive in the RPMAs in later summer 2010. The precision of estimates is improving and can be expected to continue to improve with continued sampling.

The reliability of the estimates depends on how well the assumptions are met. Of particular interest is how well the models fit the data. Unfortunately, testing goodness-of-fit for mark-recapture data and count data in general is difficult. Thus, although available procedures were employed here, it is not possible to know just how well the models fit the various datasets or where in the data lack of fit might exist. Given this, it is important to try to continue to (1) improve capture probabilities for more age classes of fish, (2) consider other covariates that might help explain any sources of heterogeneity in survival and capture probabilities, and (3) to consider other approaches for assessing the results.

Other approaches might include strategic use of radio telemetry. Alternatively, one might consider other methods of estimating population size. Here, we combined survival information with knowledge of the number of released fish to estimate population sizes of release cohorts through time. Other independent and complementary approaches to estimating abundance could be employed to try to validate these results. For example, if multiple, intensive capture sessions could be implemented in sample sections of an RPMA in a short window of time, models for estimating abundance in a closed population (e.g., Lincoln-Petersen models and more advanced forms thereof) could be used to estimate abundance. If such sampling and analysis were done, those closed-population estimates of abundance of standing stocks of pallid sturgeon could be compared from the population estimates obtained with the approach used here. Further, if such work were done in multiple years, estimation could be done using robust design models that take advantage of sampling within years of the closed population along with sampling across years of the open population.