Effectiveness of Fish Screens to Reduce Entrainment and Losses of Threatened Salmonids into Irrigation Diversions on the Lemhi River

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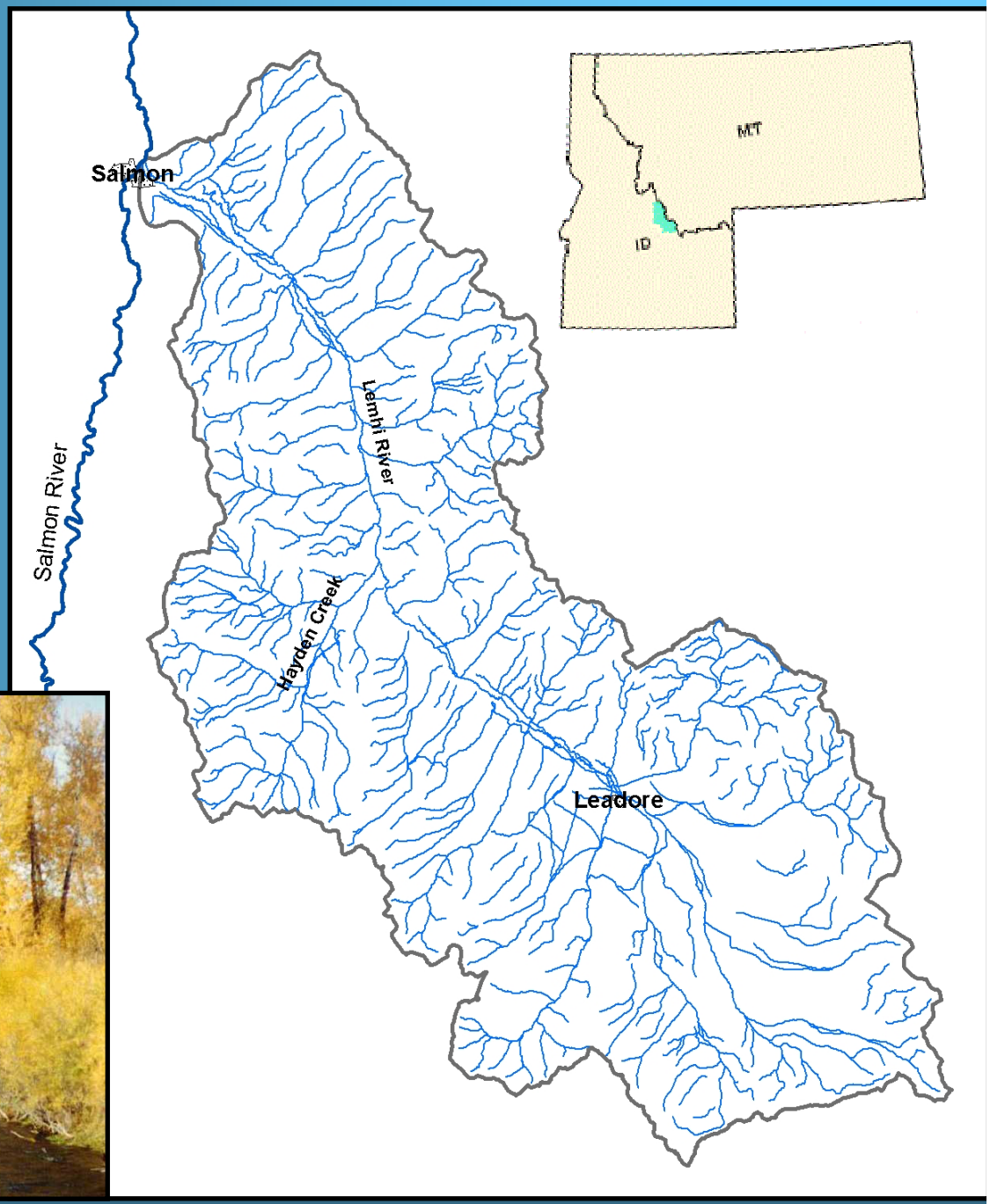
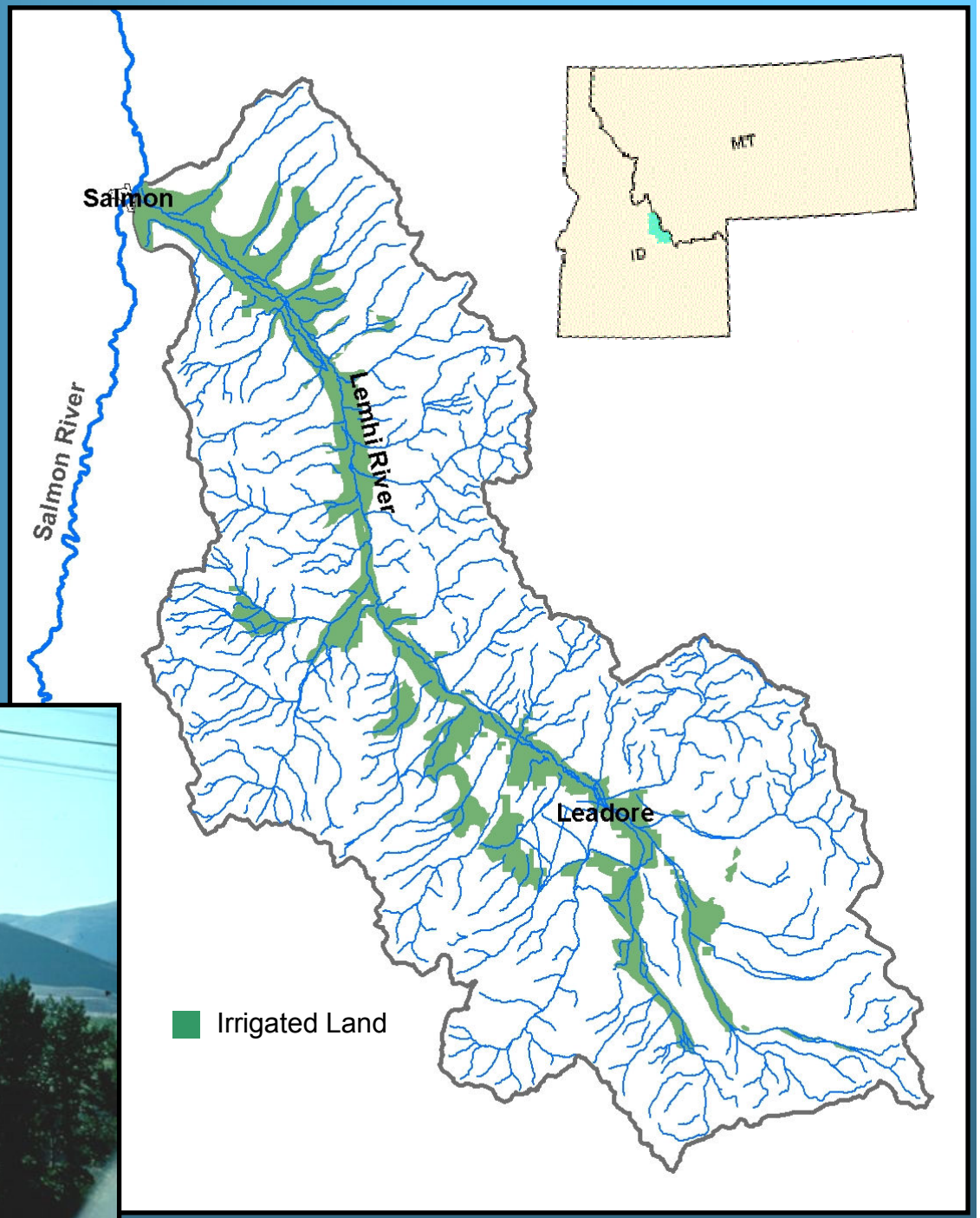
Lemhi River Subbasin

- Total Subbasin Area = 3,300 km^2
- 82% Public Land.
- 18% Private Property.
- Almost entire mainstem of Lemhi River is private property.



Lemhi River Subbasin Agriculture

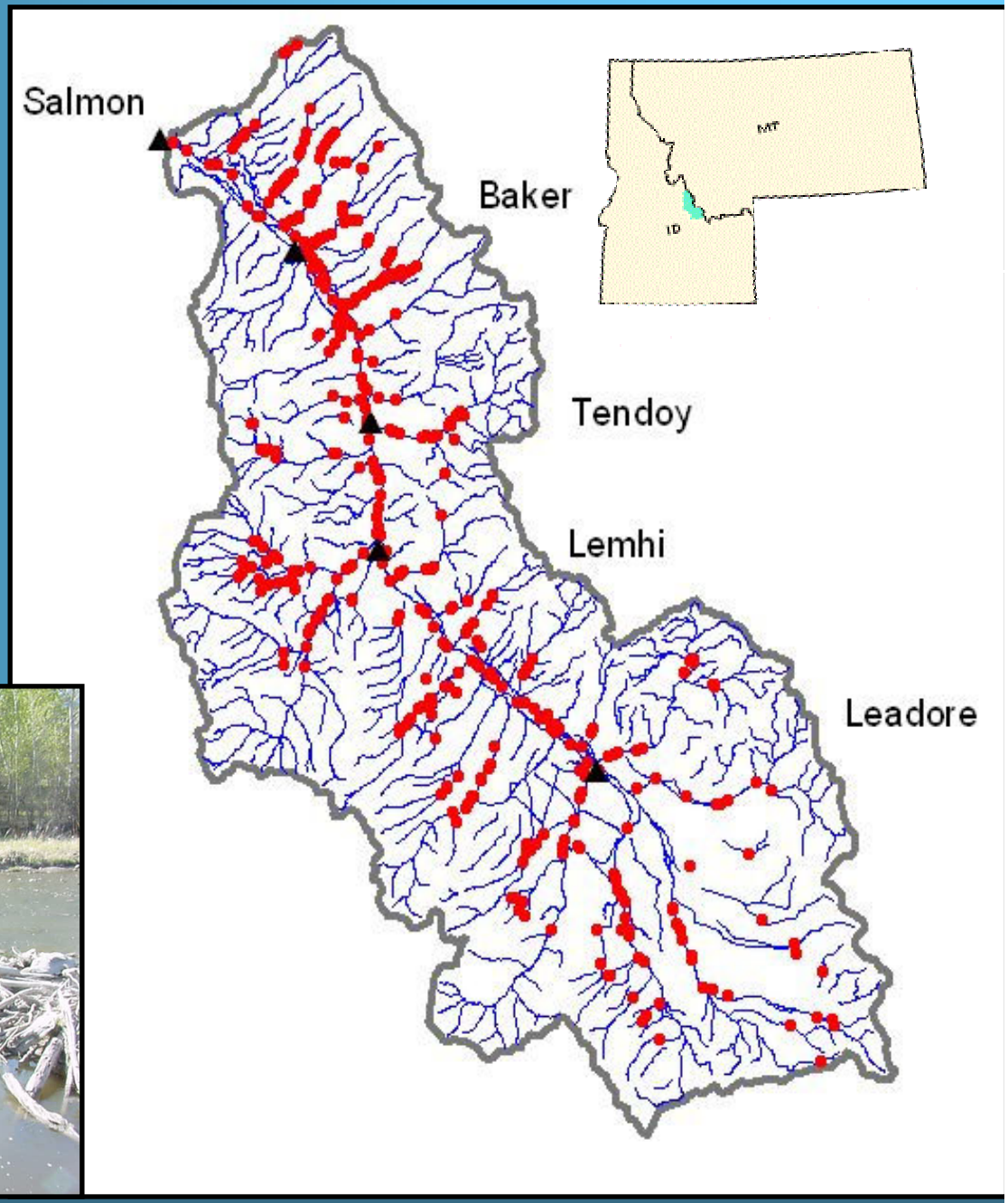
- Irrigated Area ≈22,559 ha (55,745 ac)
- Predominately hay production and pasture



Lemhi River Subbasin Agriculture

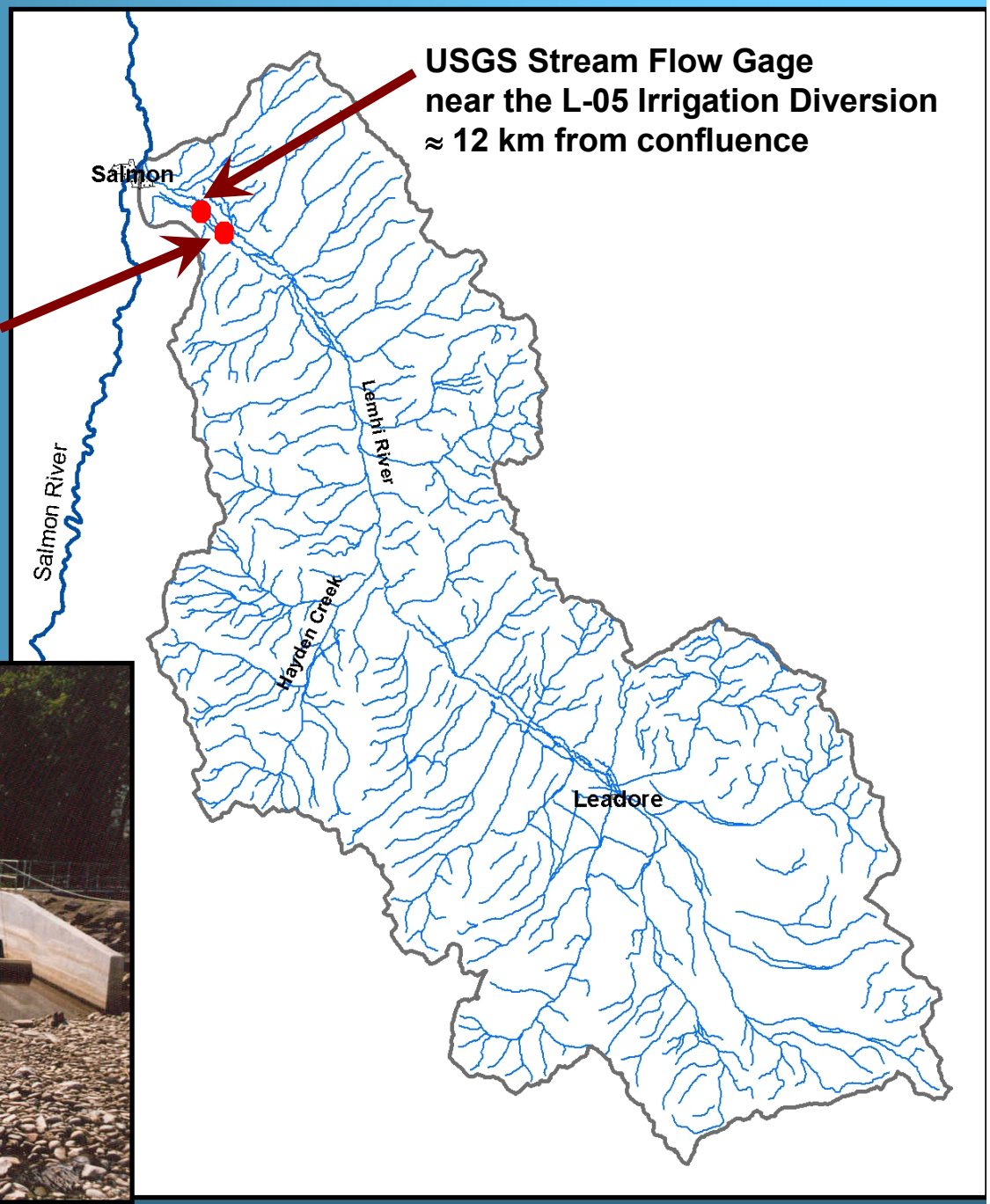
- Irrigated Area > 52,600 ha (130,000 ac)
- Predominately hay production and pasture

- Over 300 gravity diversions

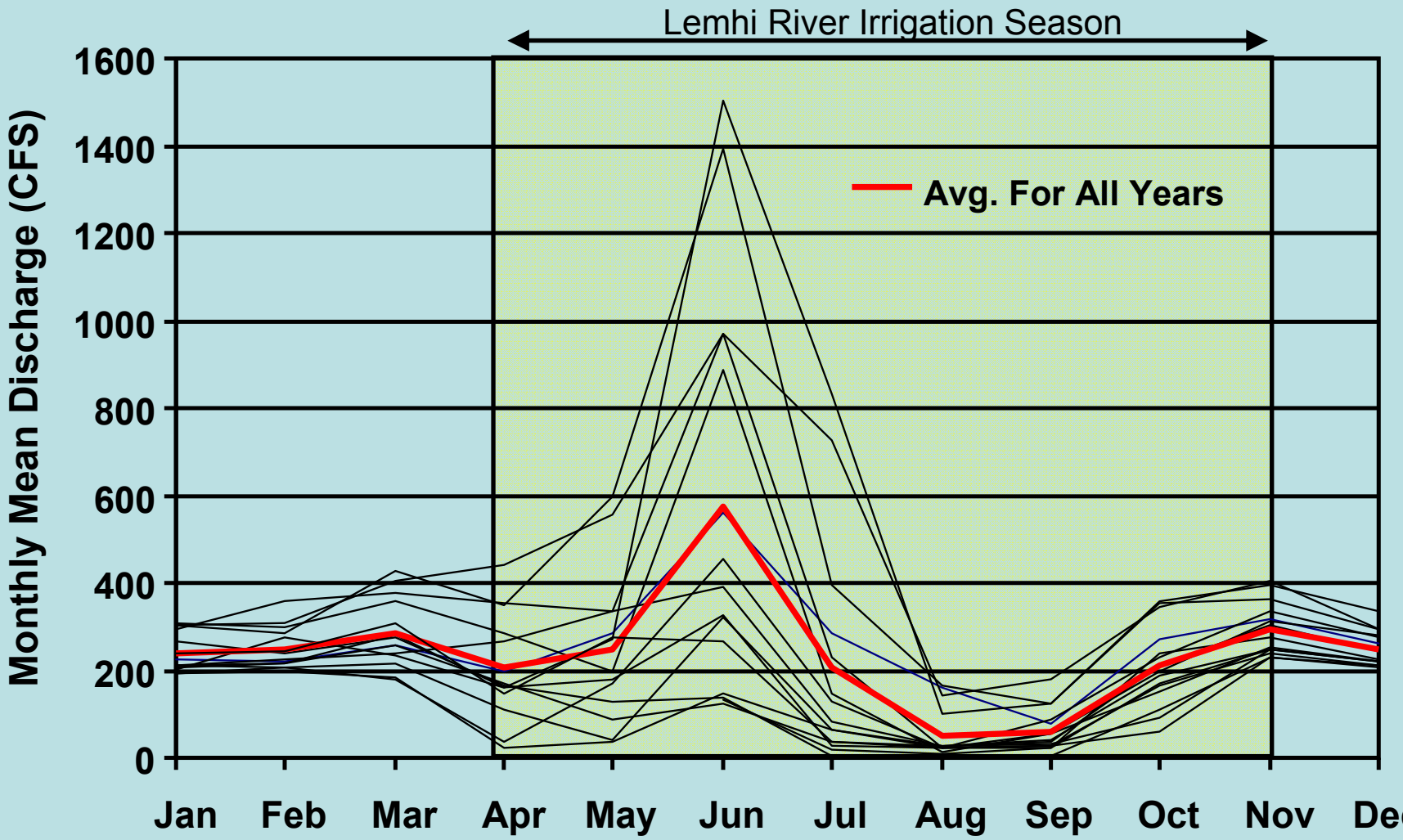


Substantial reduction in Lower Lemhi River flows due to irrigation withdrawals.

- Senior water rights carry water to the L-06 and L-07 diversions.
- Dewatering downstream of the L-06 diversion was common.

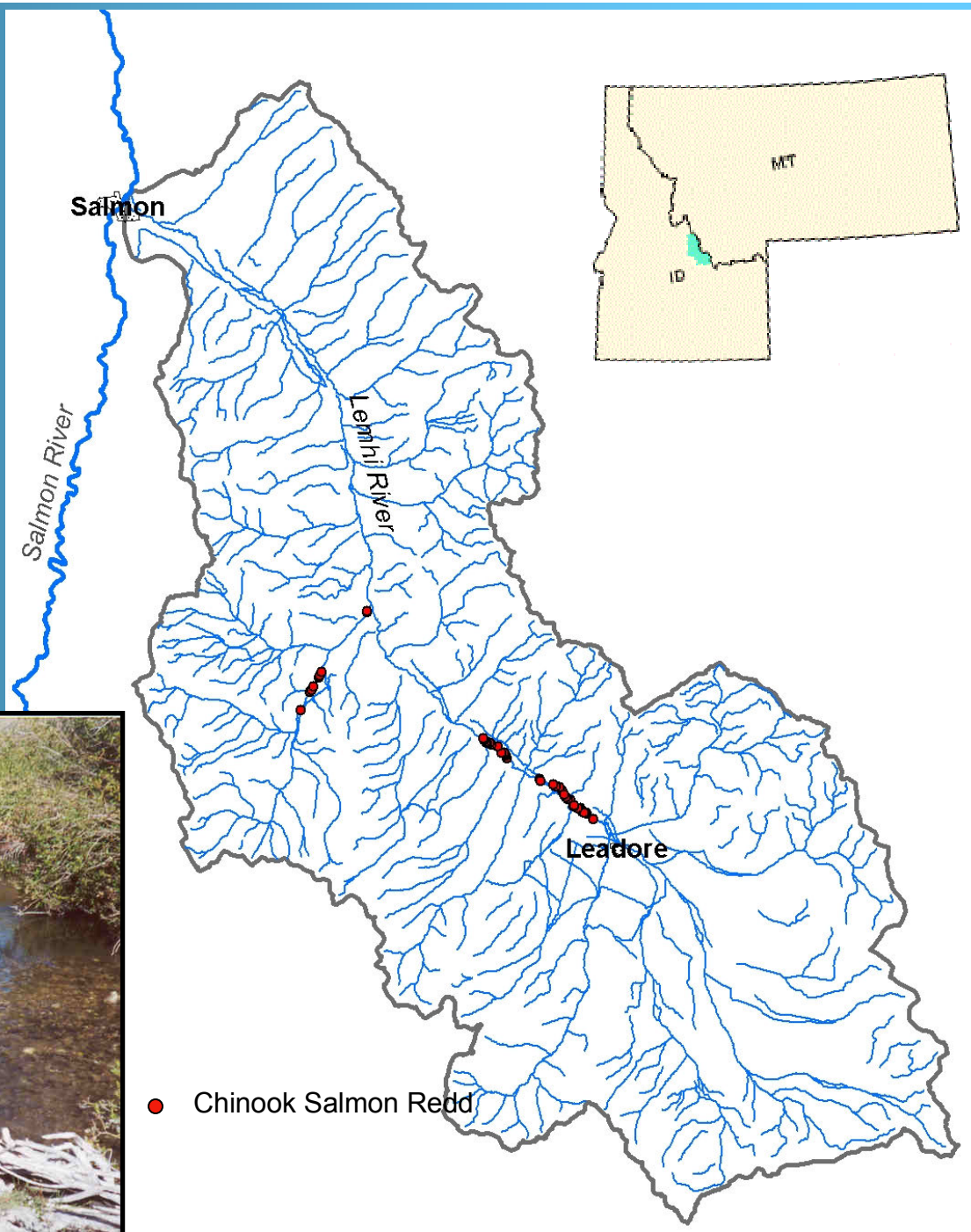


Mean Monthly Discharge at USGS Gage Station below L-05 Diversion 1993-2007



Lemhi River Fishery Resources

- Important spawning and early rearing habitat for Chinook salmon, steelhead, resident rainbow trout, westslope cutthroat trout, and bull trout.
- There were 200-1,000 redds counted annually in the 1950's and early 1960's



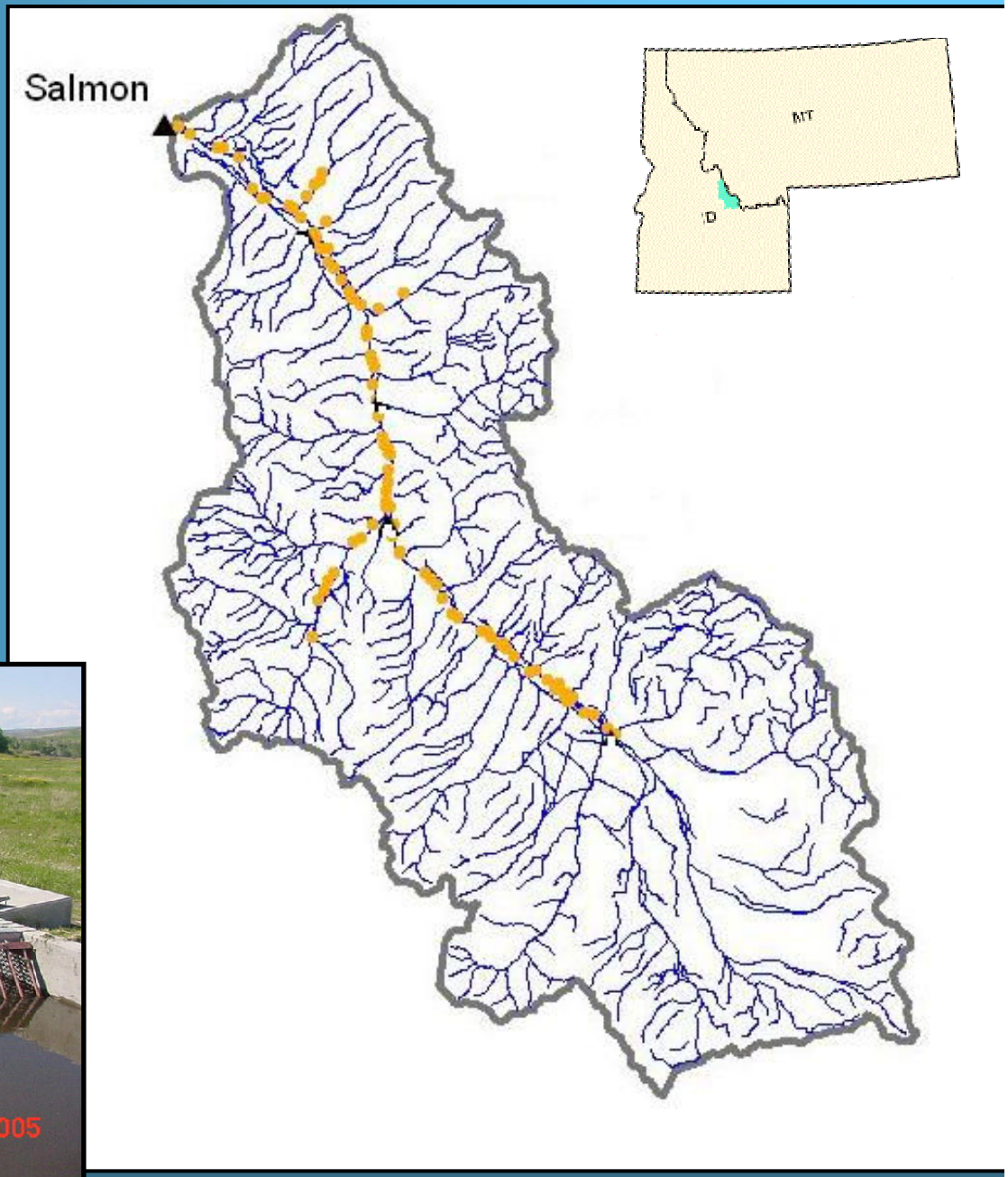
Chinook Salmon Entrainment

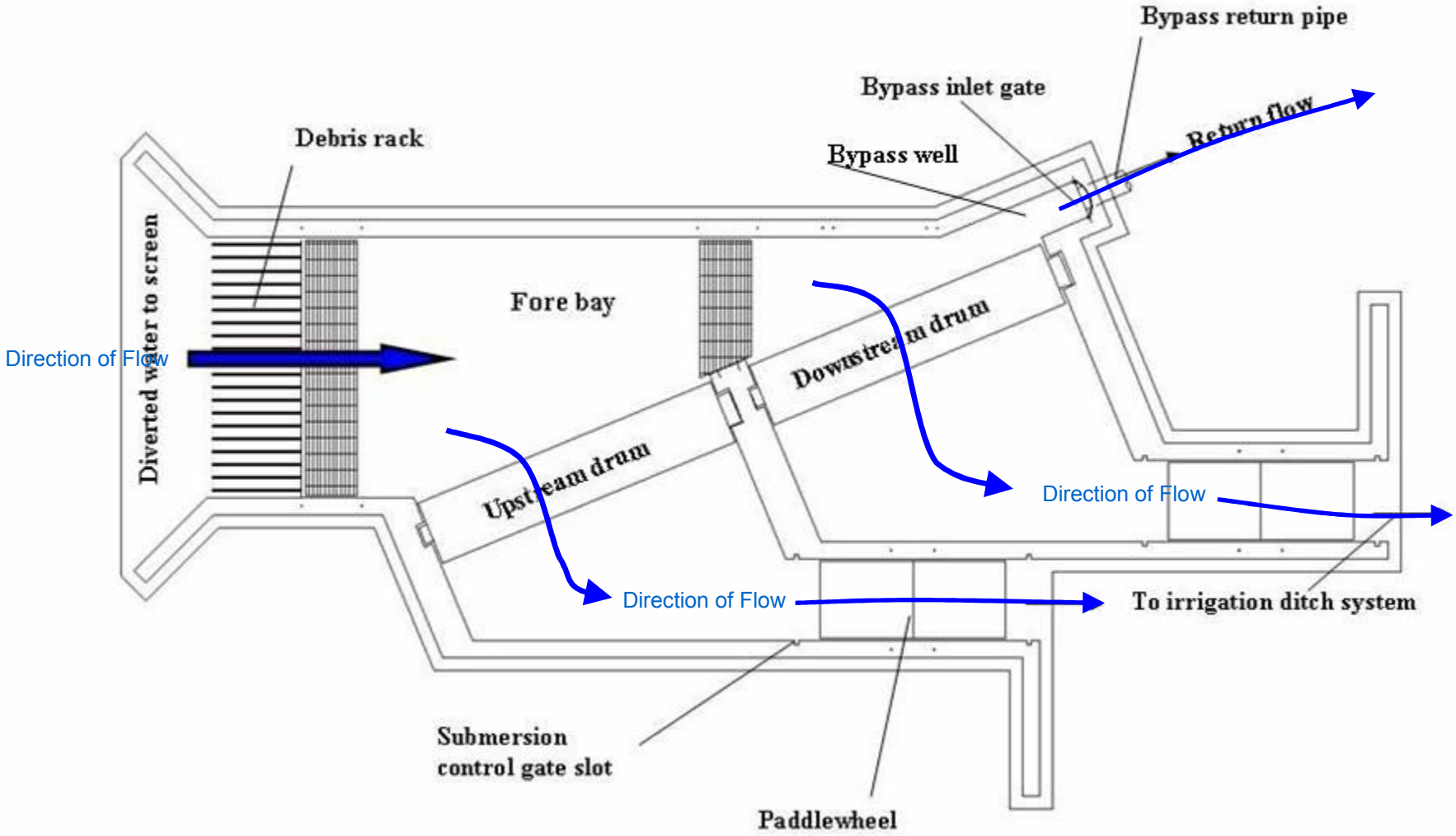
Lemhi River

- **High entrainment losses into irrigation systems provided the impetus for fish screening in the early 1960's.**
- **Gebhards (1959) estimates 423,000 salmon fingerlings lost in 90 irrigation canals.**
- **Over 350,000 were estimated to have been saved by screening in 1961 and 1962 combined (Corley 1962).**

Lemhi River Subbasin Fish Screening

- 98 Fish Screens in Subbasin
- All main stem diversions are screened (78 screens)
- Rotary drum screens
- Screens built to NMFS Juvenile Fish Screen Criteria




Bypass return pipe
Bypass inlet gate
Debris rack
Bypass well
Return flow
Diverted water to screen
Fore bay
Direction of Flow
Downstream drum
Upstream drum
Direction of Flow
Direction of Flow
To irrigation ditch system
Submersion
control gate slot
Paddlewheel

Rotating Drum Fish Screen on the L-23 Diversion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Study Objectives

- 1) Document the utilization of fish screen bypasses by juvenile Chinook salmon;
- 2) Document the correlation between the timing of the downstream migration of juvenile Chinook salmon and flows in the Lemhi River; and
- 3) Document the correlation between the rate of entrainment and flows in the Lemhi River where flows are significantly reduced due to irrigation withdrawals.

Utilization of PIT-tagged Salmonids for Documenting Entrainment

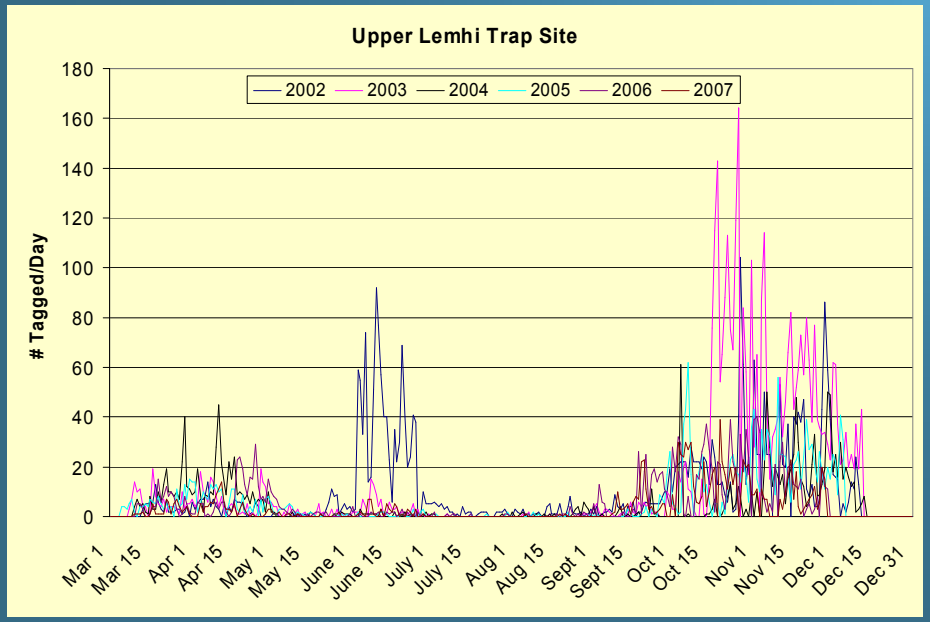
Two projects currently PIT Tagging juvenile Chinook salmon and steelhead:

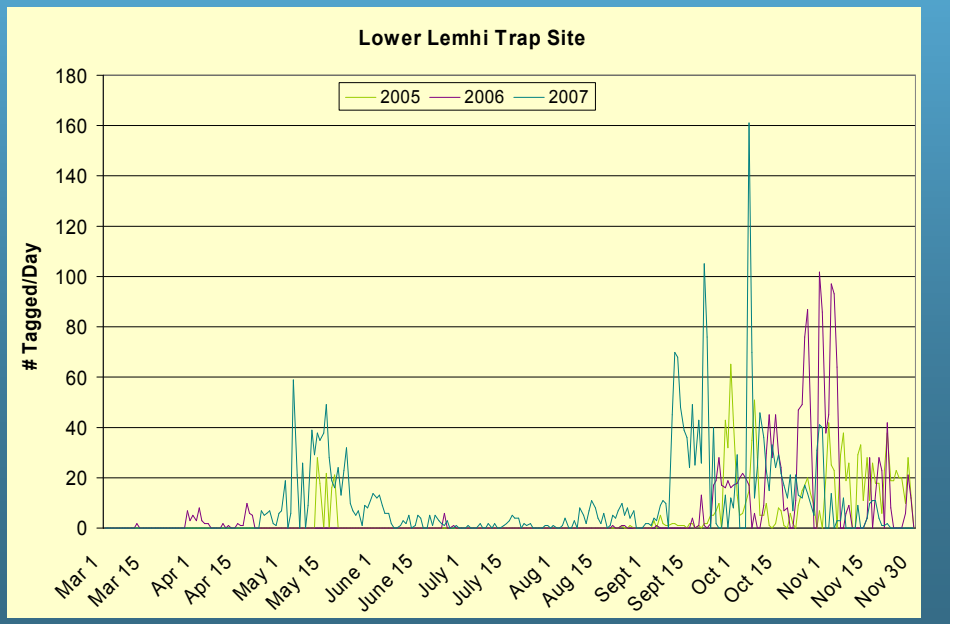
- **Idaho Supplementation Studies**
- **Lemhi Effectiveness Monitoring Program**

- **No additional handling or tagging of fish was required.**

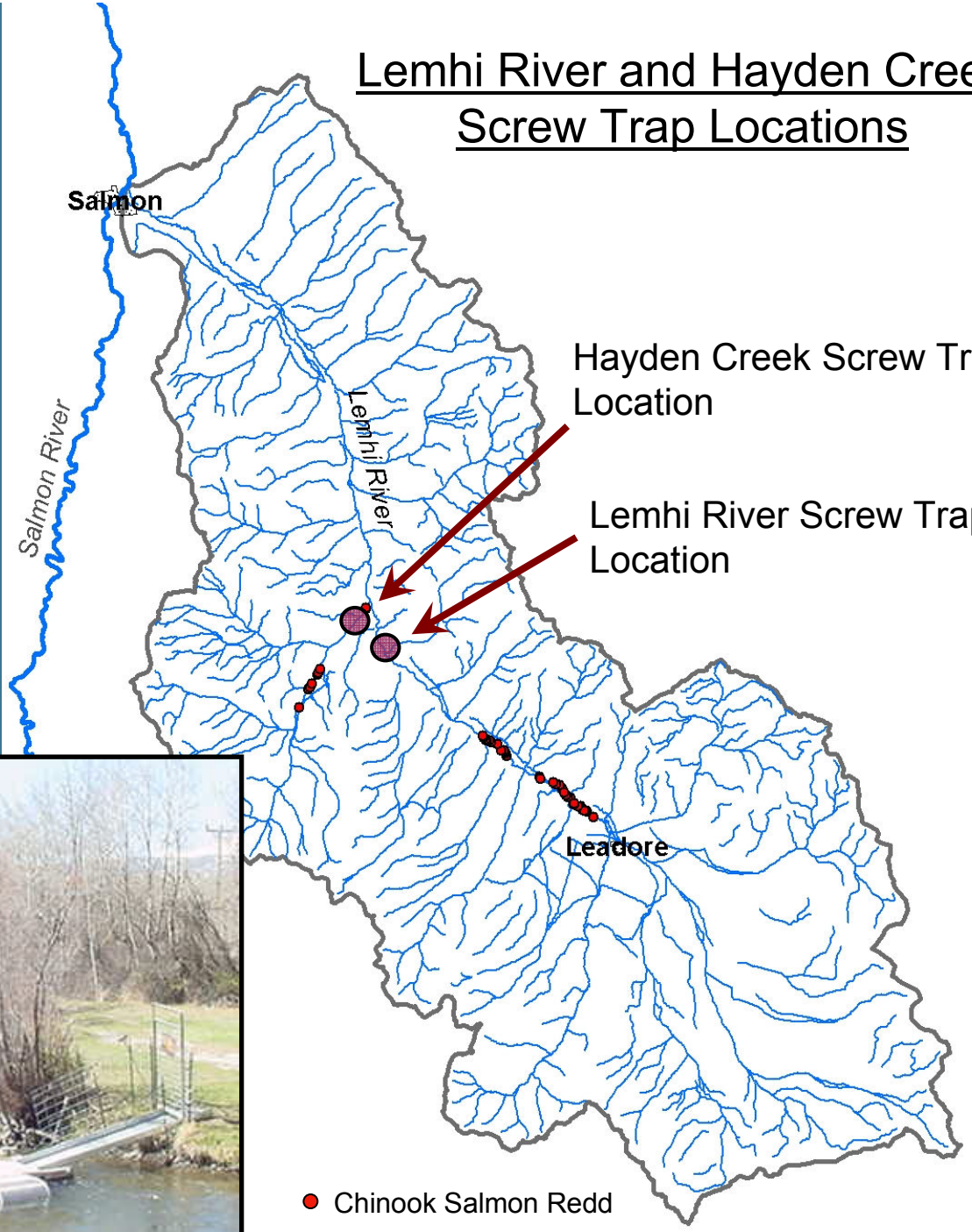
Two Groups of PIT Tagged Chinook Salmon :

- Fall tagged Chinook presmolts: Parr and early migrants generally captured and tagged any time after June 30
- Spring tagged Chinook smolts: Fish captured at screw trap and tagged as spring out-migrants prior to June 30.





Lemhi River and Hayden Creek Screw Trap Locations

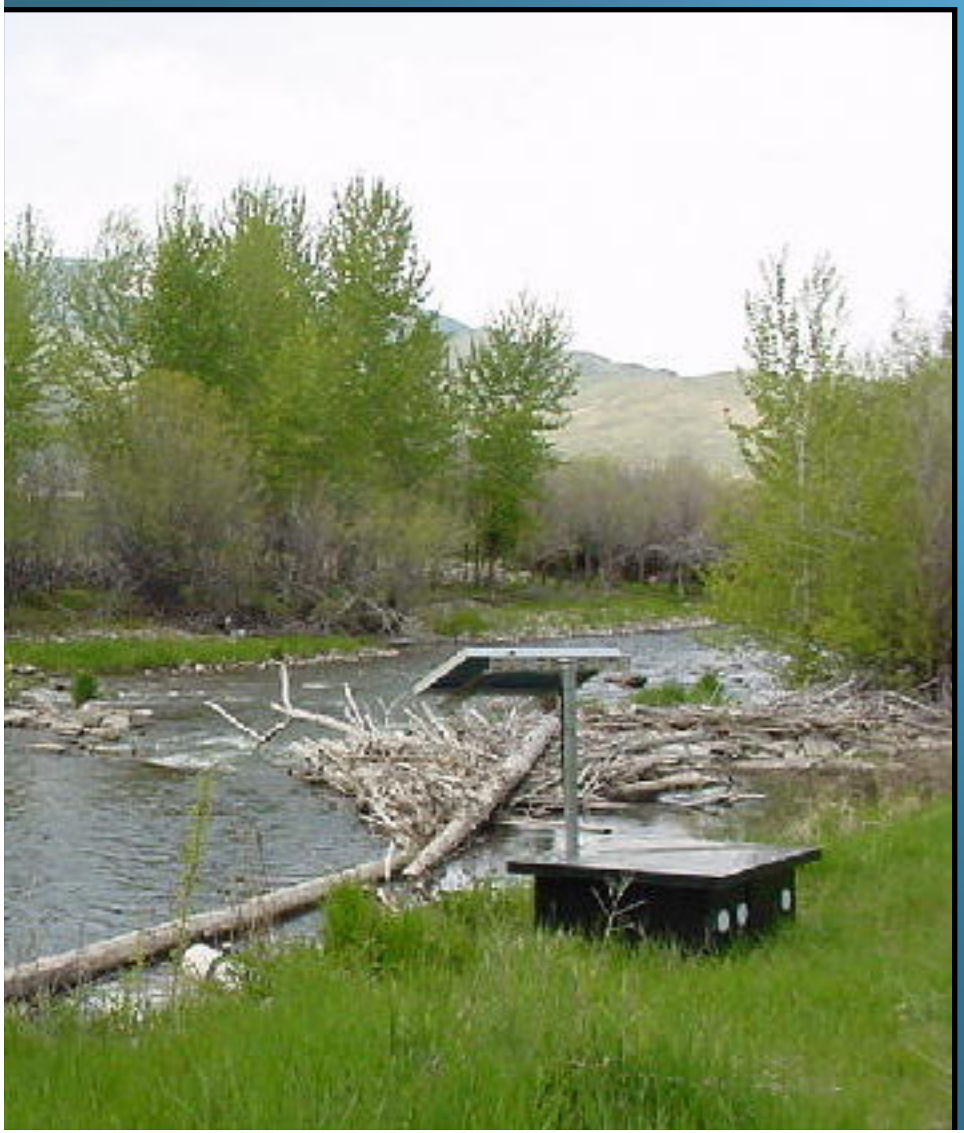


Monitoring for Entrained and Bypassed PIT Tagged Fish

Automated PIT Tag Interrogation System (Biomark, Inc.)

Programmed to record tag number and date-time bypassed

Monitoring for Entrained and Bypassed PIT Tagged Fish

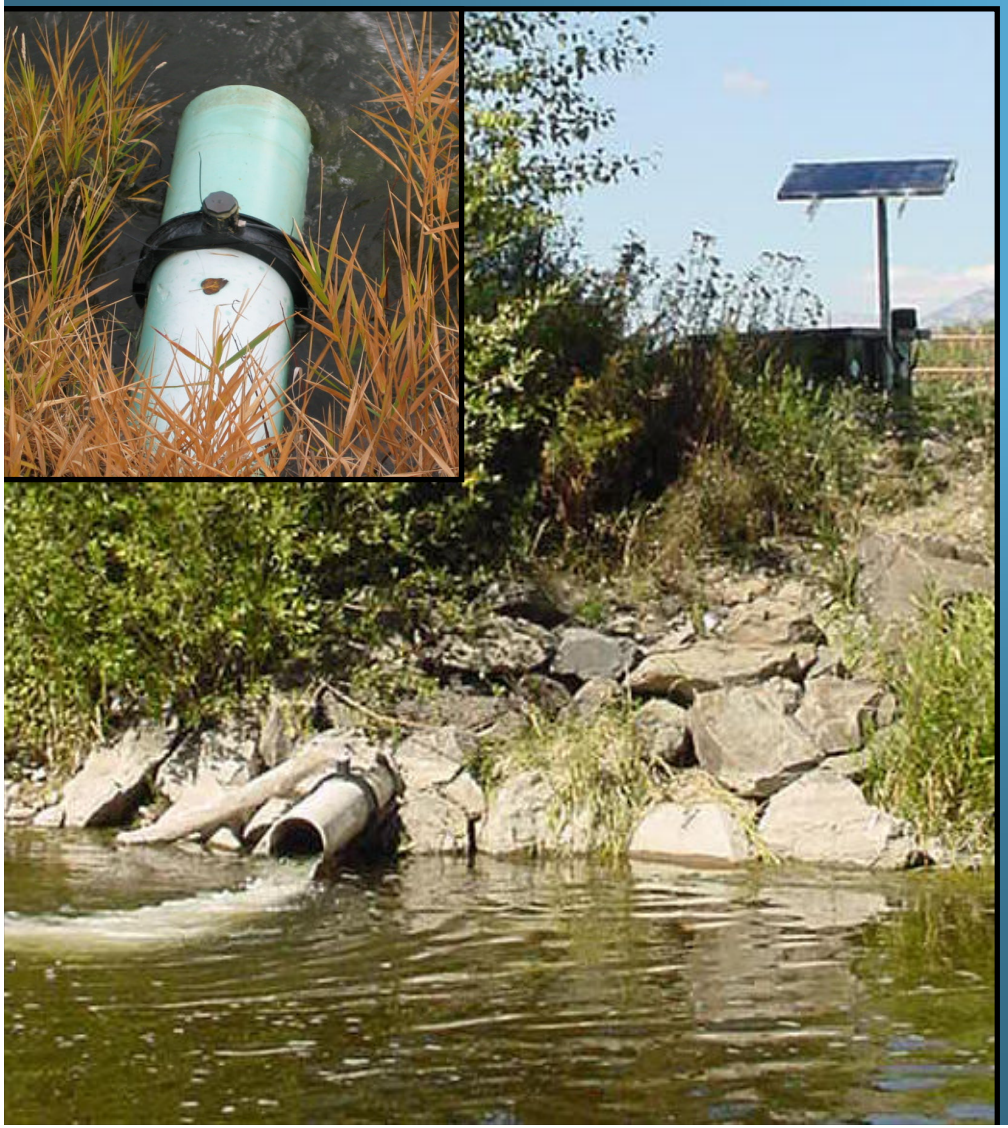


Automated PIT Tag Interrogation System (Biomark. Inc.)

Programmed to record tag number and date-time bypassed

Solar Powered Array operational 24/7 throughout irrigation season

Monitoring for Entrained and Bypassed PIT Tagged Fish



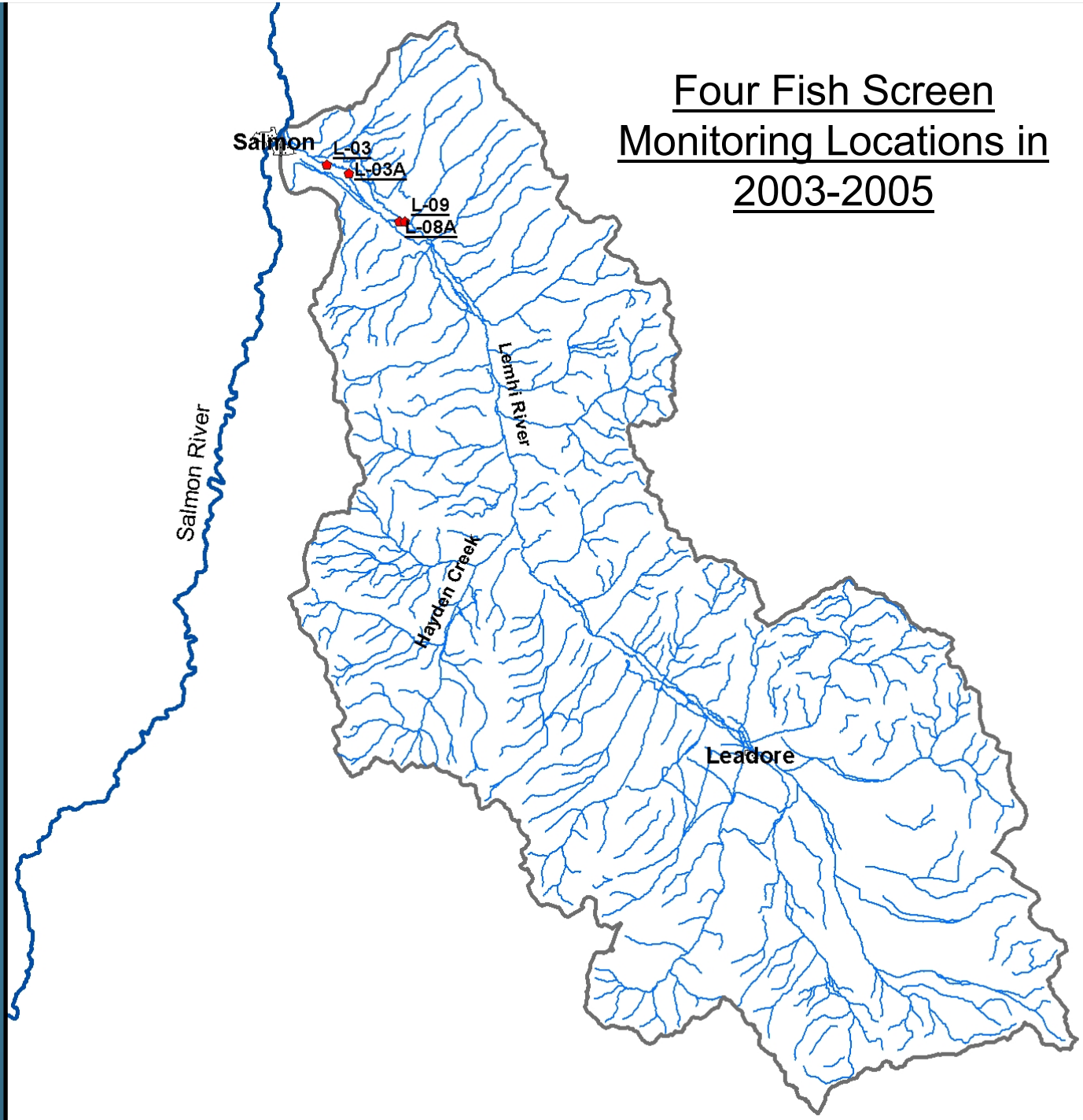
Automated PIT Tag Interrogation System (Biomark. Inc.)

Programmed to record tag number and date-time bypassed

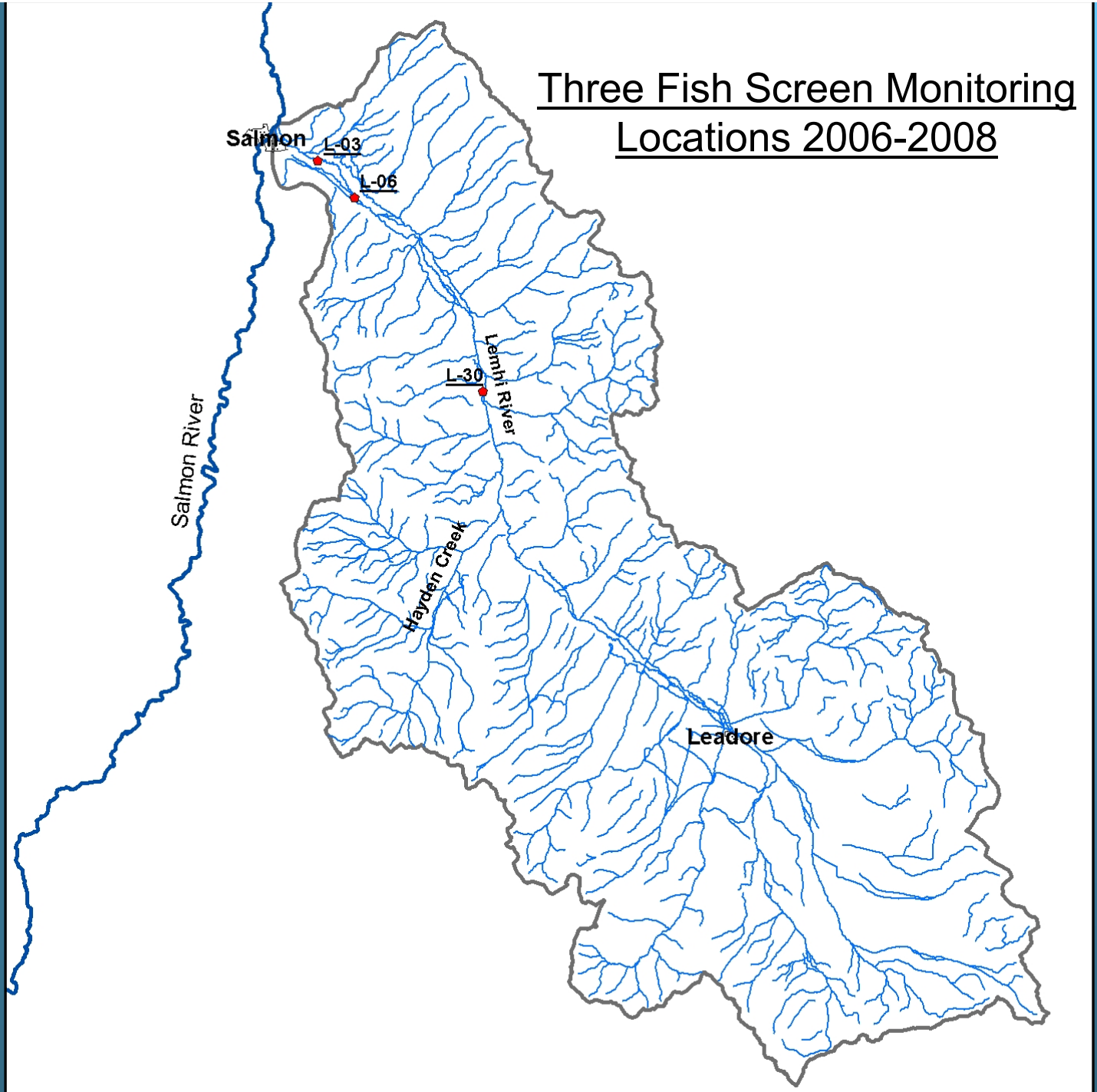
Solar Powered Array operational 24/7 throughout irrigation season

Circular Antennae at Bypass Outfall

Four Fish Screen Monitoring Locations in 2003-2005



Three Fish Screen Monitoring Locations 2006-2008

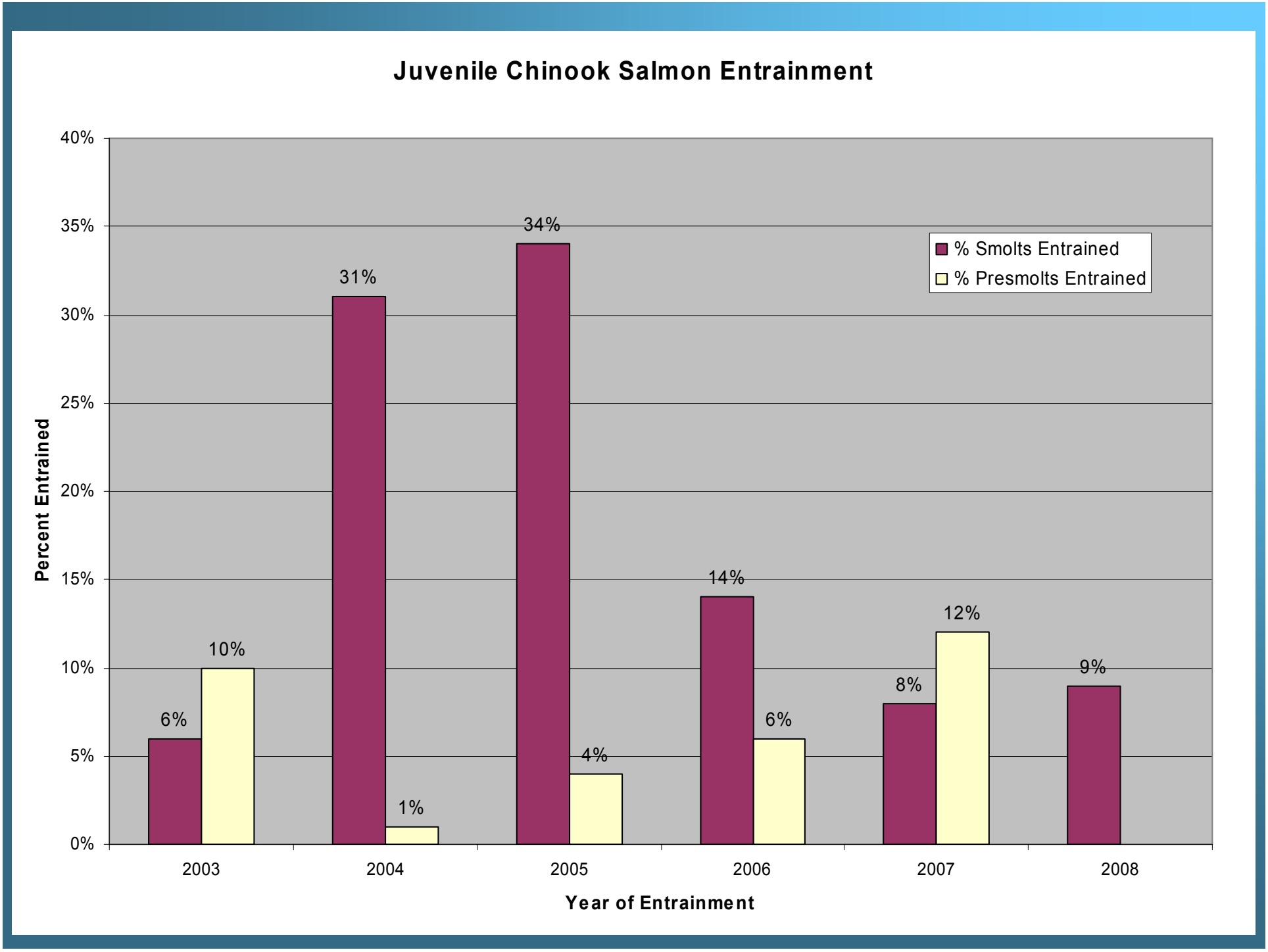


Chinook Salmon Tags

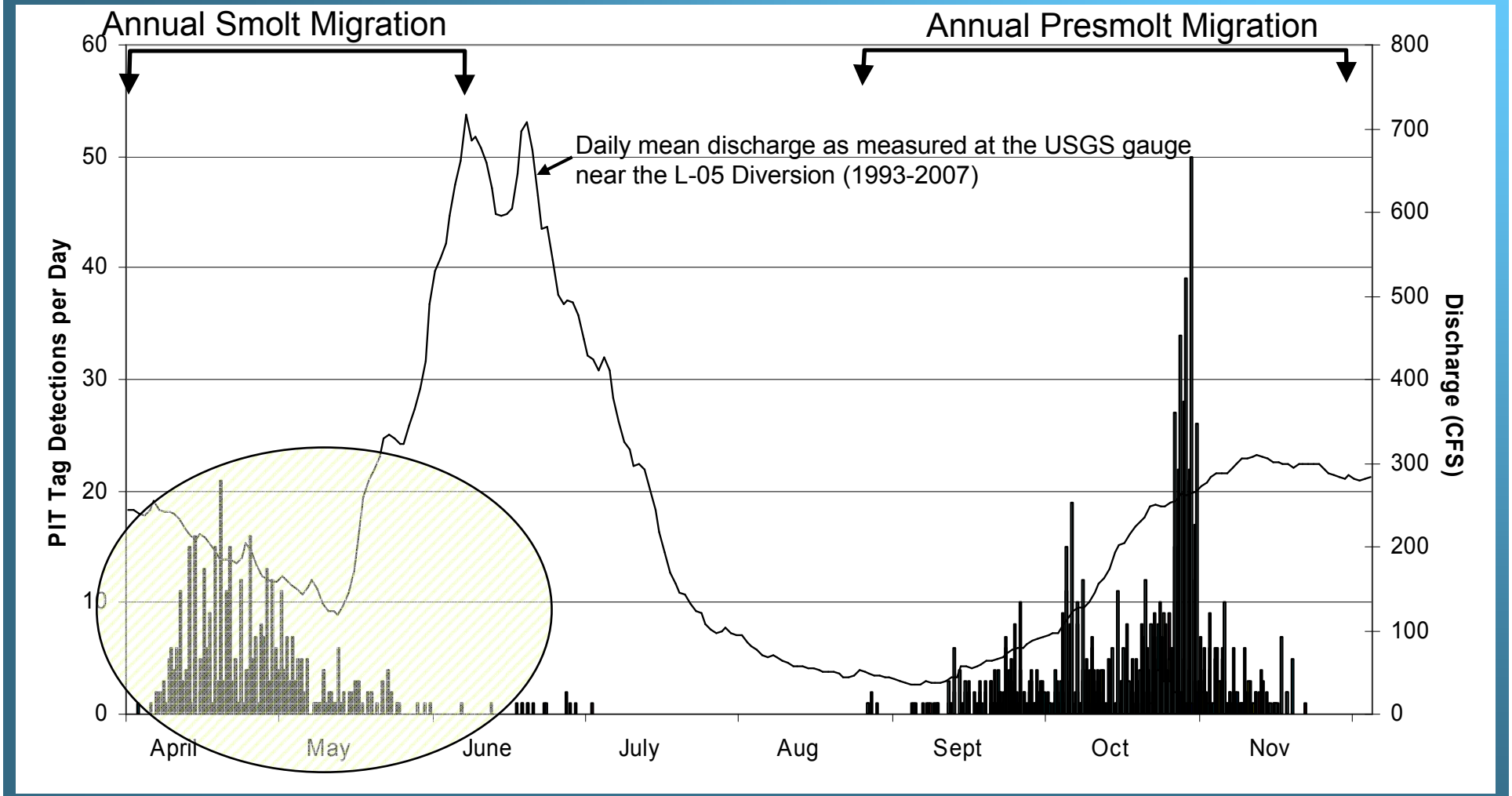
	Tag Group	Number Tagged
2001 Brood Year	2002 Presmolt	2,580
	2003 Smolt	478
2002 Brood Year	2003 Presmolt	4,147
	2004 Smolt	649
2003 Brood Year	2004 Presmolt	1,650
	2005 Smolt	406
2004 Brood Year	2005 Presmolt	2,089
	2006 Smolt	439
2005 Brood Year	2006 Presmolt	2,696
	2007 Smolt	364
2006 Brood Year	2007 Presmolt	2,829
	2008 Smolt	168

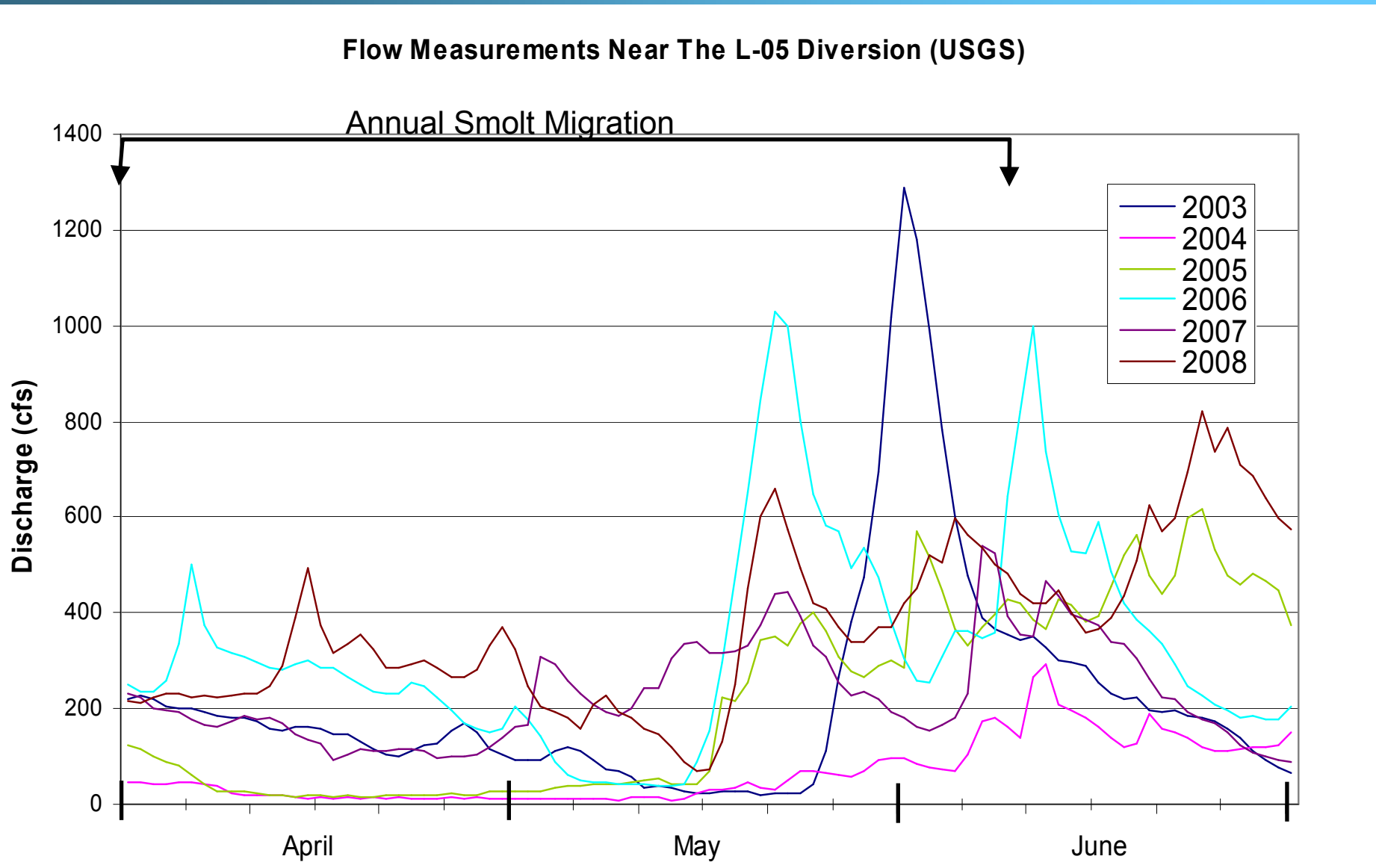
Juvenile Chinook Salmon

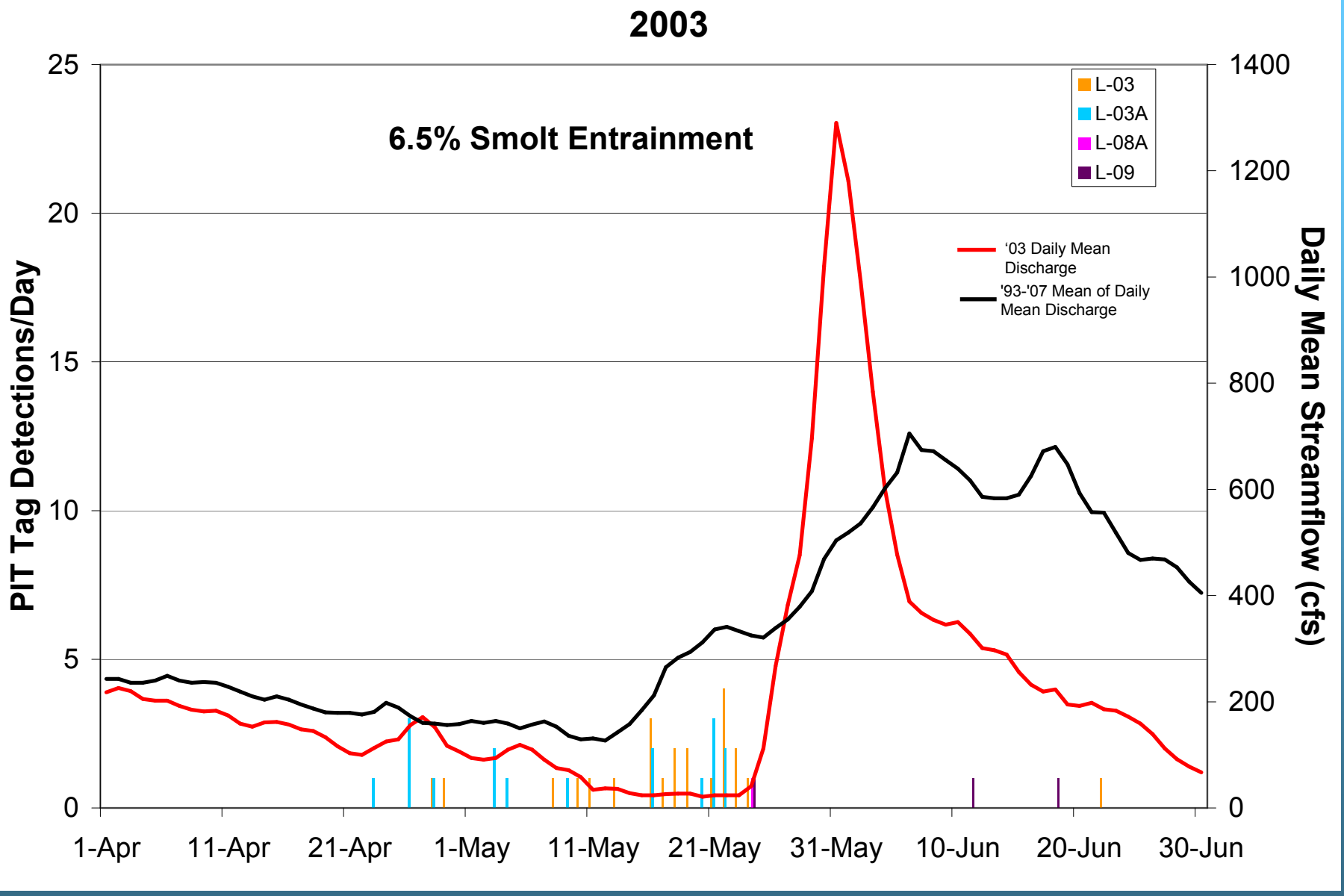
Tag Group	Number Tagged	Year of Entrainment	Entrainments per Tag Detected				Total (%) Tags Entrained
			1x	2x	3x	4x	
2002 Presmolt	2,580	2003	5	0	0	0	5 (<1%)
2003 Smolt	478	2003	22	9	0	0	31 (6%)
2003 Presmolt	4,147	2003	255	119	25	0	399 (10%)
		2004	42	2	2	0	46 (1%)
2004 Smolt	649	2004	161	33	7	1	202 (31%)
2004 Presmolt	1,650	2004	15	1	0	0	16 (1%)
		2005	18	3	0	0	21 (1%)
2005 Smolt	406	2005	89	37	11	1	138 (34%)
2005 Presmolt	2,089	2005	78	3	0	0	81 (4%)
		2006	1	2	0	-	3 (<1%)
2006 Smolt	439	2006	55	5	0	-	60 (14%)
2006 Presmolt	2,696	2006	161	4	0	-	165 (6%)
		2007	9	0	0	-	9 (<1%)
2007 Smolt	364	2007	28	3	0	-	31 (8%)
2007 Presmolt	2,829	2007	325	18	1	-	344 (12%)
		2008	5	0	0	-	5 (<1%)
2008 Smolt	168	2008	15	1	0	-	16 (9%)

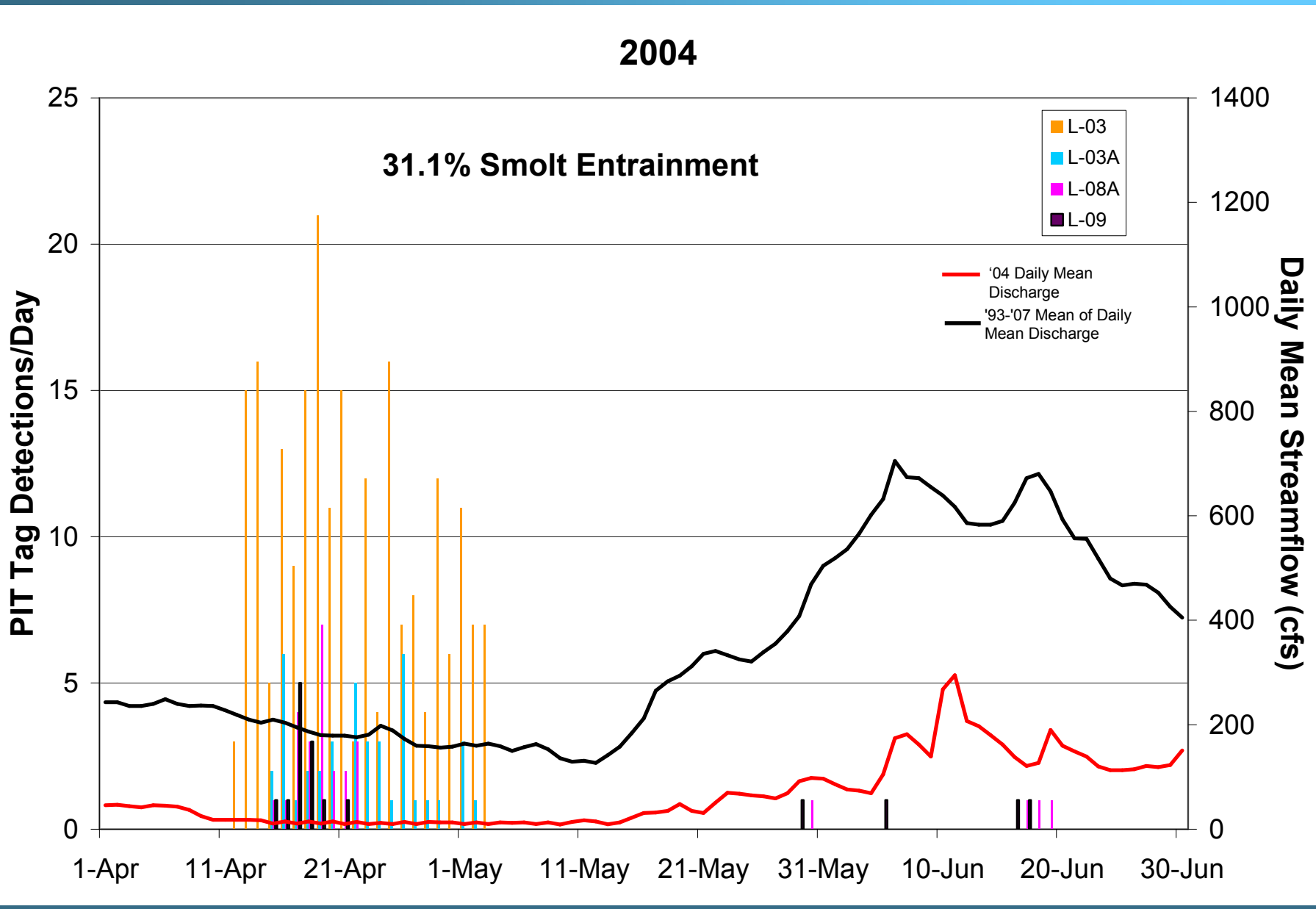

Juvenile Chinook Salmon Entrainment
40%
35%
30%
25%
20%
15%
10%
5%
0%
Percent Entrained
% Smolts Entrained
% Presmolts Entrained
6%
10%
31%
1%
34%
4%
14%
6%
8%
12%
9%
2003
2004
2005
2006
2007
2008
Year of Entrainment

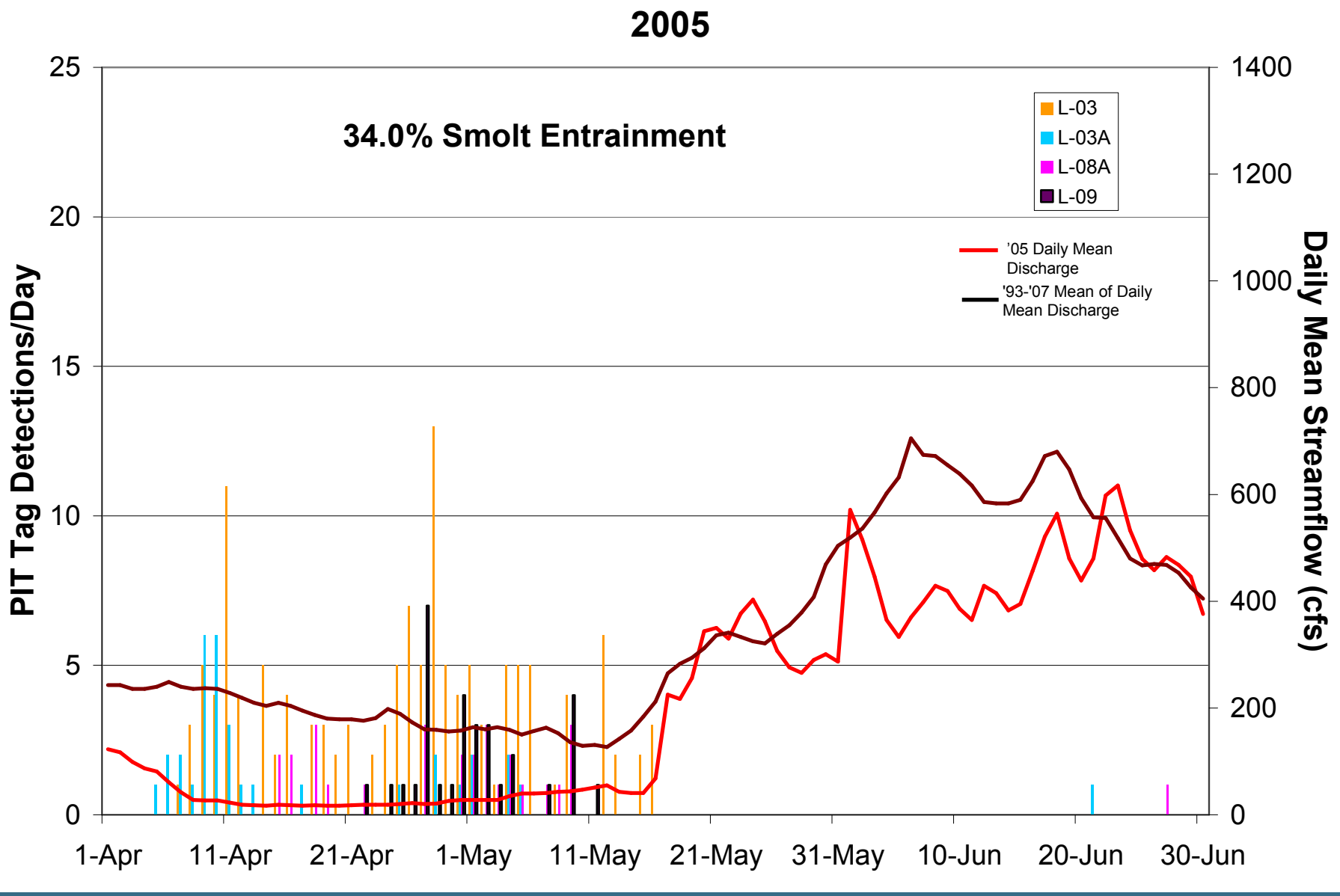
Number of PIT Tagged Juvenile Chinook Salmon Entrained per Day and Daily Mean Discharge

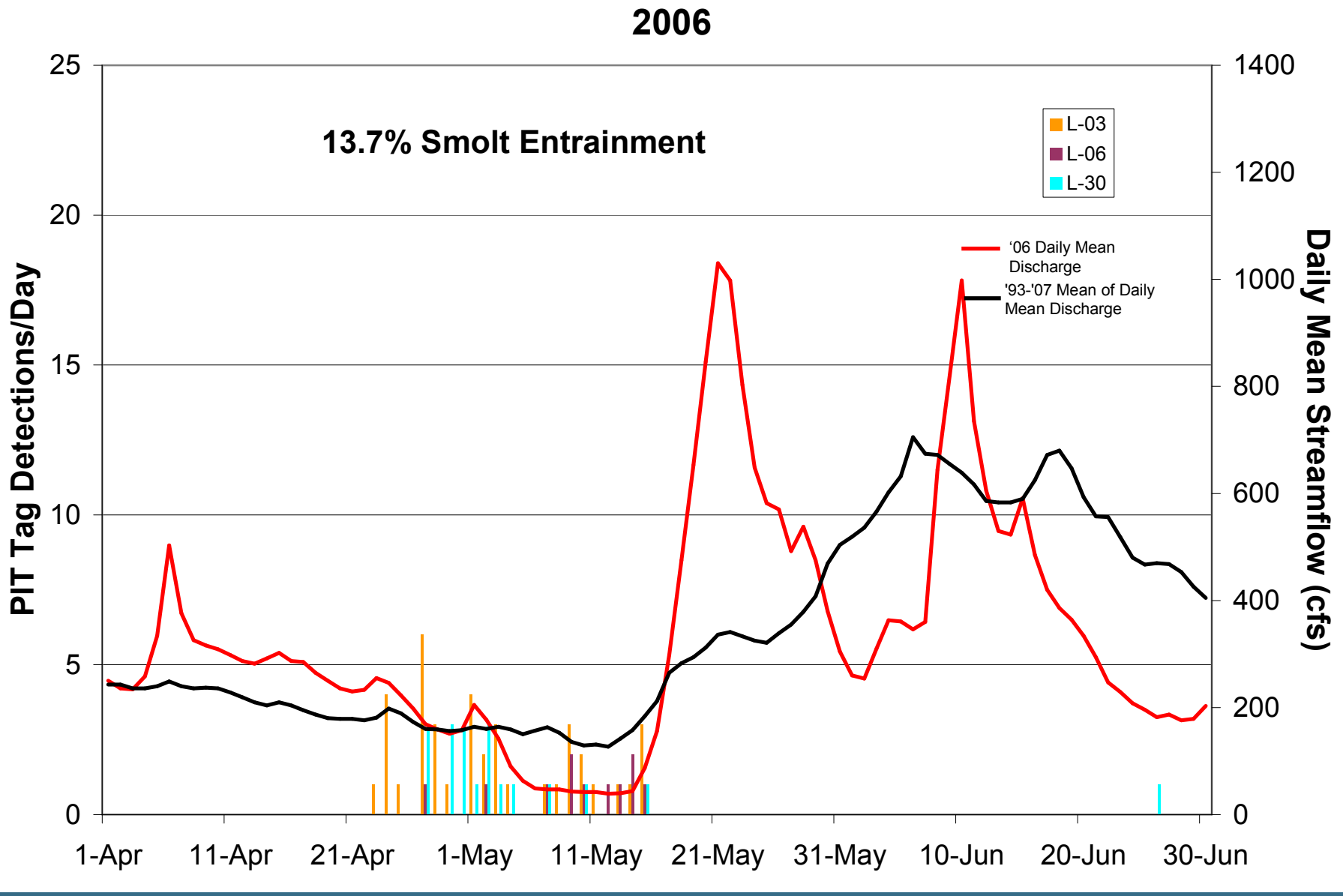


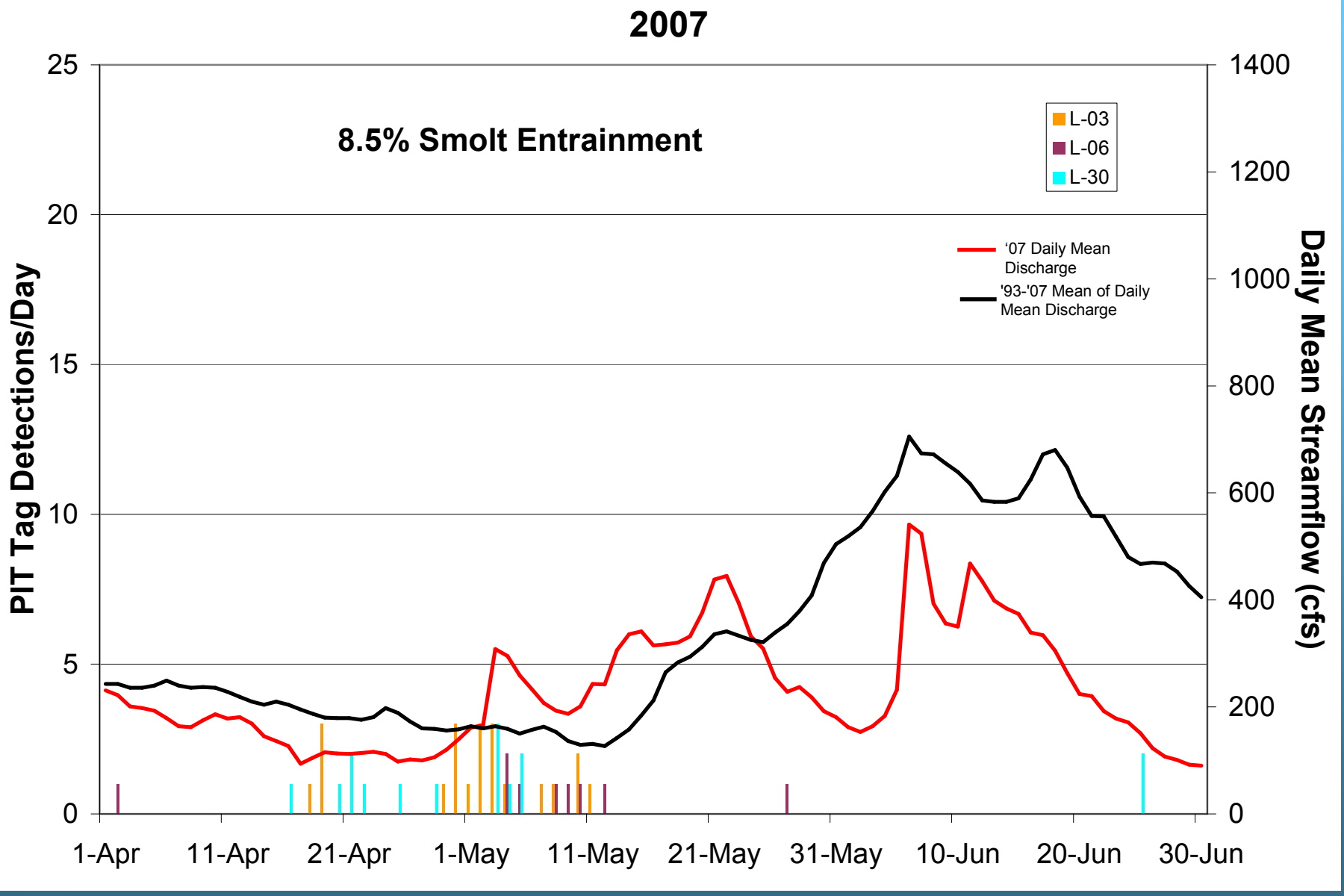

Flow Measurements Near The L-05 Diversion (USGS)
Annual Smolt Migration
Discharge (cfs)
1400
1200
1000
800
600
400
200
0
April
May
June
2003
2004
2005
2006
2007
2008

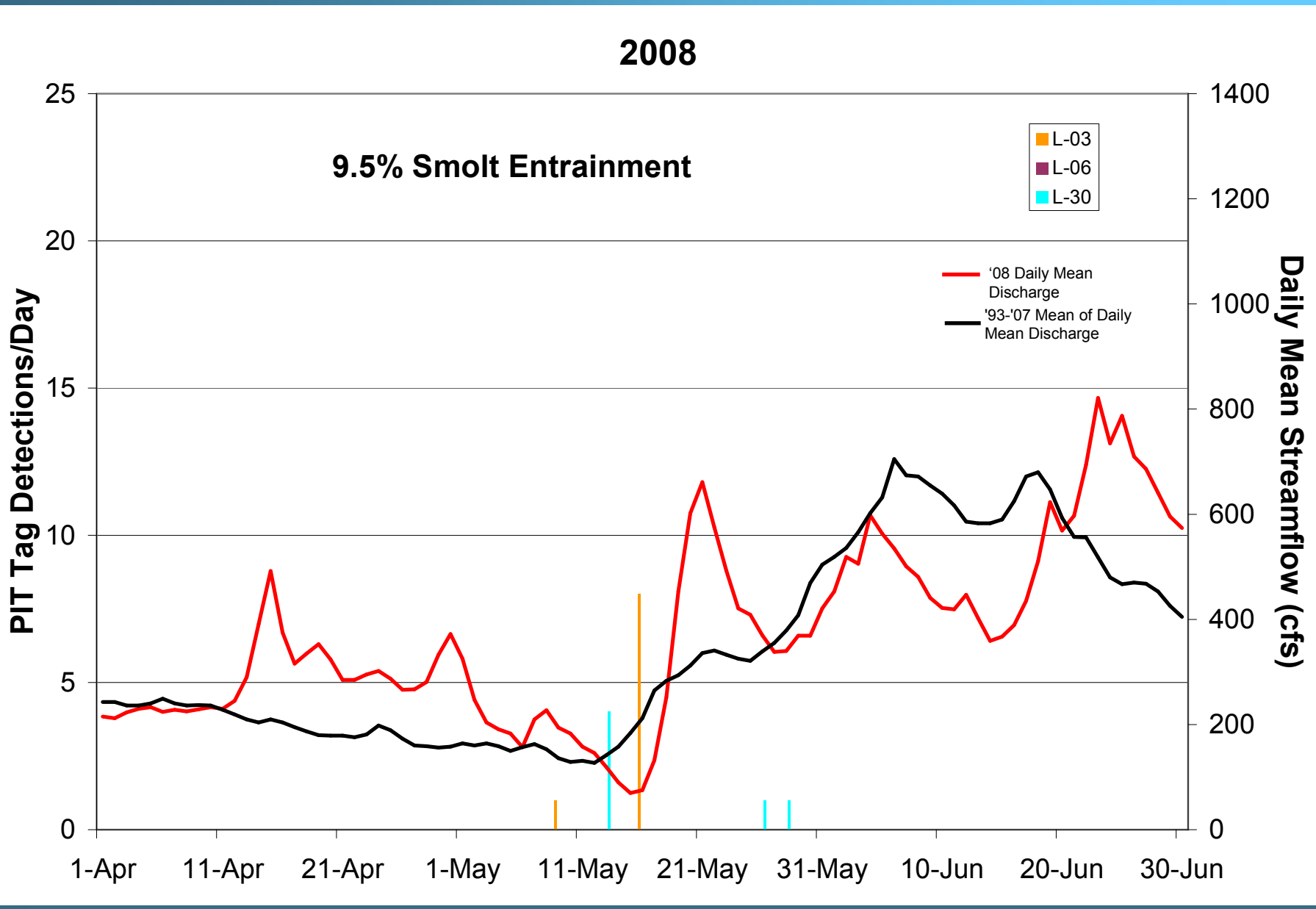

2003
6.5% Smolt Entrainment
PIT Tag Detections/Day
Daily Mean Streamflow (cfs)
L-03
L-03A
L-08A
L-09
'03 Daily Mean Discharge
'93-'07 Mean of Daily Mean Discharge
25
20
15
10
5
0
1400
1200
1000
800
600
400
200
0
1-Apr
11-Apr
21-Apr
1-May
11-May
21-May
31-May
10-Jun
20-Jun
30-Jun

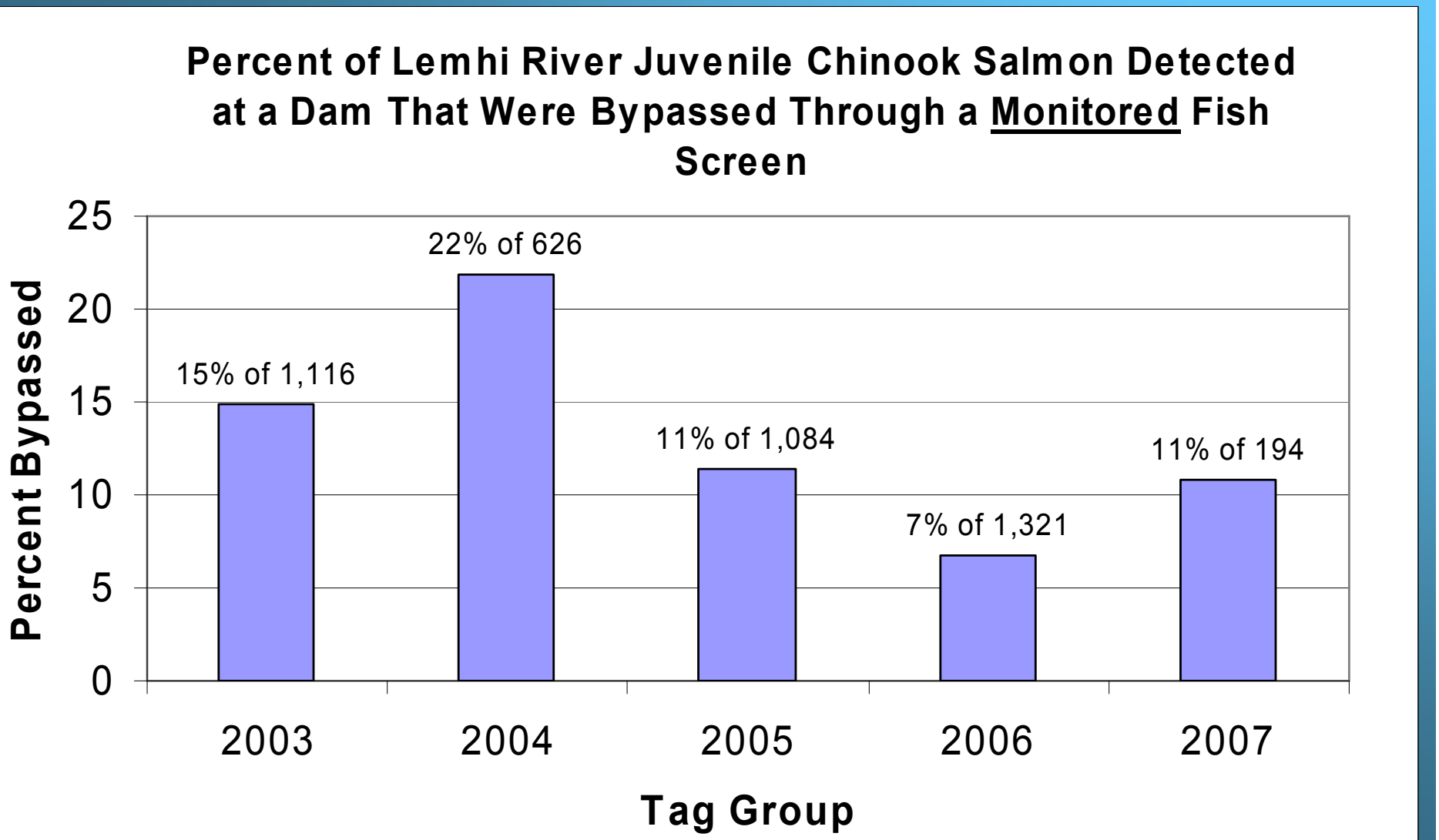

2004
31.1% Smolt Entrainment
L-03
L-03A
L-08A
L-09
'04 Daily Mean Discharge
'93-'07 Mean of Daily Mean Discharge
PIT Tag Detections/Day
Daily Mean Streamflow (cfs)
25
20
15
10
5
0
1400
1200
1000
800
600
400
200
0
1-Apr
11-Apr
21-Apr
1-May
11-May
21-May
31-May
10-Jun
20-Jun
30-Jun


2005
34.0% Smolt Entrainment
L-03
L-03A
L-08A
L-09
'05 Daily Mean Discharge
'93-'07 Mean of Daily Mean Discharge
PIT Tag Detections/Day
Daily Mean Streamflow (cfs)
25
20
15
10
5
0
1400
1200
1000
800
600
400
200
0
1-Apr
11-Apr
21-Apr
1-May
11-May
21-May
31-May
10-Jun
20-Jun
30-Jun


2006
13.7% Smolt Entrainment
L-03
L-06
L-30
'06 Daily Mean Discharge
'93-'07 Mean of Daily Mean Discharge
PIT Tag Detections/Day
Daily Mean Streamflow (cfs)
25
20
15
10
5
0
1400
1200
1000
800
600
400
200
0
1-Apr
11-Apr
21-Apr
1-May
11-May
21-May
31-May
10-Jun
20-Jun
30-Jun


2007
8.5% Smolt Entrainment
L-03
L-06
L-30
'07 Daily Mean Discharge
'93-'07 Mean of Daily Mean Discharge
PIT Tag Detections/Day
Daily Mean Streamflow (cfs)
0
5
10
15
20
25
0
200
400
600
800
1000
1200
1400
1-Apr
11-Apr
21-Apr
1-May
11-May
21-May
31-May
10-Jun
20-Jun
30-Jun


2008
9.5% Smolt Entrainment
L-03
L-06
L-30
'08 Daily Mean Discharge
'93-'07 Mean of Daily Mean Discharge
PIT Tag Detections/Day
Daily Mean Streamflow (cfs)
25
20
15
10
5
0
1400
1200
1000
800
600
400
200
0
1-Apr
11-Apr
21-Apr
1-May
11-May
21-May
31-May
10-Jun
20-Jun
30-Jun


Percent of Lemhi River Juvenile Chinook Salmon Detected at a Dam That Were Bypassed Through a Monitored Fish Screen
Percent Bypassed
25
20
15
10
5
0
15% of 1,116
22% of 626
11% of 1,084
7% of 1,321
11% of 194
2003
2004
2005
2006
2007
Tag Group

Conclusions and Discussion

- Overall, 1,581 (8.5%) of the PIT tagged juvenile Chinook salmon were entrained through at least one monitored bypass out of a total of 78 bypasses on the mainstem of the Lemhi River since 2003.
- These estimates are conservative, detection efficiencies may be 75% - 90%, depending on conditions.
- A strong negative correlation exists between instream flows and entrainment rates.
- Variables affecting entrainment rates include instream flows, different rates of diversions at various head gates, timing of migration.

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