Detection of Passive Integrated Transponder (PIT) Tags on Piscivorous Bird Colonies in the Columbia River Basin, 2001

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Report of research by

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Walla Walla, Washington 99362-1876
Delivery Order 2RL4SPTP00

September 2003

EXECUTIVE SUMMARY

In 2001, the National Marine Fisheries Service detected the passive integrated transponder (PIT) tags of 45,065 juvenile salmonids on piscivorous bird colonies in the Columbia River Basin. These PIT tags accounted for 4.1% of the 1,099,291 PIT-tagged juvenile salmonids released into the Columbia River Basin to migrate during 2001. By species, they accounted for 8.7, 4.8, 3.4, and 2.6% of the PIT-tagged steelhead *Oncorhynchus mykiss*, coho *O. kisutch*, chinook *O. tshawytscha*, and sockeye salmon *O. nerka* respectively.

Piscivorous bird colonies sampled were of Caspian terns (*Sterna caspia*), double-crested cormorants *Phalacrocorax auritas*, gulls *Larus* spp., American white pelicans *Pelecanus erythrorhynchos*, and three species of heron: *Ardea alba, A. herodias,* and *Nycticorax nycticorax*. The greatest number of tags was detected on East Sand Island in the Columbia River estuary.

At Bonneville Dam (the first impoundment upstream from the Columbia River estuary), 47,246 PIT tagged juvenile salmonids were detected in the bypass systems in 2001, of which 12,847 originated in the Snake River Basin (SRB). Detections on bird colonies accounted for 24.2% of the SRB steelhead and 10.1% of the SRB spring/summer chinook salmon previously detected at Bonneville Dam. Of the remaining 34,399 non-SRB tags detected at Bonneville Dam, detections on the bird colonies accounted for 13.4, 10.3, 7.7, and 4.7% of the coho, steelhead, sockeye and chinook salmon, respectively.

The second greatest number of tags was detected on Crescent Island in the McNary Dam reservoir. Upstream from Crescent Island at Lower Monumental Dam (the nearest upstream PIT tag detection facility), 48,779 juvenile spring/summer chinook and 15,486 steelhead tags from migration year 2001 were detected. Of these, 13.0% of the steelhead and 4.1% of the spring/summer chinook salmon were detected on the Crescent Island tern colony.

Due to the low water flow and lack of spill in 2001, 168,734 PIT-tagged juvenile salmonids were barged around the Federal Columbia River Power System and released downstream from Bonneville Dam, which was a substantial increase compared to previous years. Of these we detected 6,405 tags, which accounted for 9.3, 7.5, 3.4, and 2.1% of the transported PIT-tagged coho, steelhead, chinook, and sockeye, respectively.

In addition, we PIT tagged 8,754 juvenile salmonids during migration year 2001 and released them into rivers that discharge directly into the Columbia River estuary. From these releases, we detected 15.9, 8.4, and 3.7% of the fall chinook, steelhead and

spring chinook salmon, respectively. While detection percentages of steelhead and spring chinook salmon were not that different from those of upriver stocks, the percentage of fall chinook salmon detected was significantly higher than that of their upriver cohorts.

Our PIT-tag detections in 2001 continue to provide minimum estimates of avian predation in the Columbia River Basin along with relative vulnerabilities of juvenile salmonids. In addition, these data were entered into the Columbia Basin PIT Tag Information System for use by other researchers and salmon managers.

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INTRODUCTION

Since 1991, the National Marine Fisheries Service (NMFS) has listed 12 evolutionarily significant units (ESUs) of Pacific salmon (*Oncorhynchus* spp.) in the Columbia River Basin as threatened or endangered under the U.S. Endangered Species Act (NMFS 2000). Under its mandate to identify and protect depressed or endangered salmonid populations, NMFS has undertaken research on several fronts, from evaluating criteria to define these genetically distinct populations (Waples 1991) to identifying causes of their decline at different life history stages (NMFS 2000).

Recovery planning is at the forefront of this research, which includes a recent evaluation of the effects on chinook salmon (*O. tshawytscha*) demographics of potential reductions in mortality at different life stages (Kareiva et al. 2000). This evaluation found that reductions as low as 5% in early ocean and estuarine mortality could arrest population declines. Ironically, even as the habitats and life history stages central to recovery are beginning to be identified, growing populations of piscivorous birds present an additional risk to salmonid populations in these same habitats and life history stages (Collis et al. 2001a).

Colonies of Caspian terns (*Sterna caspia)* along the north Pacific coast have expanded rapidly, from 3,500 breeding pairs in 1960 to 12,500 in 2001 (USACE 2001). Since the mid-1960s, Caspian tern colonies have shifted northward from California and by the 1980s began to concentrate on small islands in the Columbia River estuary (Gill and Mewladt 1983). In 2001, 9,100 breeding pairs of Caspian terns were estimated near the mouth of the Columbia River on East Sand Island (Figure 1)(Collis et al. 2001b).

Colonies of double-crested cormorants (*Phalacrocorax auritas*) also expanded rapidly in the Columbia River estuary, from initial sightings in the 1980s (Carter et al. 1995) to over 7,000 breeding pairs in 2001 (C. Anderson, Oregon State University, personal communication).

In addition to terns and cormorants nesting in the Columbia River estuary, there are at least nine islands in the lower Columbia River Basin that host colonies of piscivorous birds. These birds include terns, cormorants, gulls (*Larus* spp.), American white pelicans (*Pelecanus erythrorhynchos*), and three species of herons (*Ardea alba, A. herodias,* and *Nycticorax nycticorax*).

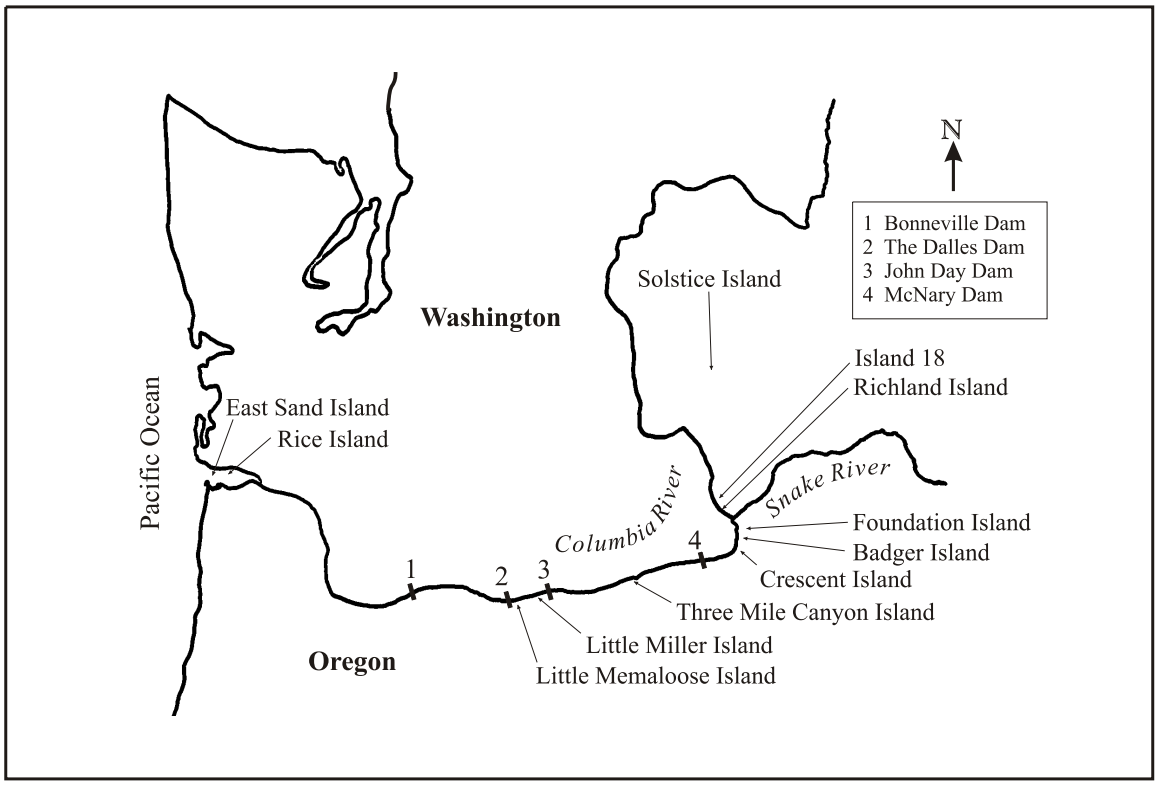

Figure 1. Locations of avian nesting areas where PIT tags were detected in the Columbia River Basin, 2001.

To evaluate the effects on juvenile salmonids of piscivorous birds nesting in the Columbia River Basin, we used juvenile salmonids tagged with passive integrated transponders (PIT). A PIT tag is a microchip bonded to an antenna coil and sealed in a glass cylinder, measuring 2.1 mm in diameter and 12 mm in length (Prentice et al. 1990a). When a PIT tag is within range of a magnetic field generated by a detection antenna it is energized and transmits its unique electronic code to the antenna (Prentice et al. 1990b). At the time of tagging, individual PIT-tag codes and information such as species and origin are recorded in the Columbia Basin PIT Tag Information System (PTAGIS), a regional database (PSMFC 1996). Codes in PTAGIS can be matched with records of subsequent detection and used to determine the migration history, and often the ultimate fate, of an individual fish.

Since 1987, juvenile salmonids have been PIT tagged to evaluate measures implemented to improve their survival through the Federal Columbia River Power System (FCRPS). The total number of PIT-tagged juvenile salmonids released in the Columbia River Basin varies each year, but has increased from less than 50,000 in 1987 to over 1 million in 2001 (PSMFC 1996).

In 1998, NMFS began detecting juvenile salmonid PIT-tags on piscivorous bird colonies in the Columbia River Basin (Ryan et al. 2001). These tag codes have been used to analyze bird feeding behavior, prey selectivity, and the relative vulnerability of various groups of juvenile salmonids to avian predators (Collis et al. 2001a; Ryan et al. 2003).

Prior to 2001, PIT-tagged salmonids had been released throughout the Columbia River Basin; however, no PIT-tagged salmonids had been released from populations residing in streams and rivers that discharge directly into the Columbia River estuary. These stocks may be more vulnerable to avian predators nesting in the estuary if they rely more heavily on estuarine habitat than their upriver counterparts. For example, Reimers (1973) found a diverse number of estuary rearing periods and strategies for fall chinook salmon in the Sixes River, Oregon. To evaluate whether estuarine salmonids were more vulnerable to predation, we tagged a subset of these salmonids to compare with their upriver counterparts.

Here we report the results of continuing PIT-tag detection efforts on piscivorous bird colonies in the Columbia River Basin in 2001 along with our estuary PIT-tagging effort. These data will be added to a growing database (PTAGIS) that will be used to evaluate the relative vulnerability of juvenile salmonids based on species, rear-type, and migration history.

STUDY SITE

Our study site ranged from East Sand Island (RKm 8) near the mouth of the Columbia River to Solstice Island in the Potholes Reservoir (Figure 1), approximately 40 km east of the Wanapum Reservoir in the Columbia River (RKm 665). The sampling locations within our study site consisted of 15 bird colonies on 11 islands.

Columbia River Estuary

East Sand Island (RKm 8) hosted a colony of Caspian terns and a separate colony of double-crested cormorants. The tern colony consisted of about 9,100 breeding pairs on 1.6 ha of open sand (Collis et al. 2001b). The cormorant colony consisted of about 7,000 breeding pairs (Collis et al. 2001b) on a 500 by 30-m colony situated on a jetty of large boulders. Rice Island (RKm 34) hosted a colony of about 200 breeding pairs of cormorants on 0.7 ha of open sand (C. Anderson, Oregon State University, personal communication).

The Dalles Dam Reservoir—Lake Celilo

Little Memaloose Island (RKm 314) hosted a gull colony[1] with a population index[2] of about 300 on a small rock island (0.2 ha). Little Miller Island (RKm 331) hosted a gull colony, with a population index of about 1,700 on several small rock outcroppings (0.5 ha), and a small colony of terns with a population index of 20.

John Day Dam Reservoir—Lake Umatilla

Three Mile Canyon Island (RKm 412) hosted tern and gull colonies. The tern colony had a population index of about 500 on 0.05 ha of open sand; however, the nest site was abandoned in early June due to predation by a mink (*Mustela vision*) (Collis et al. 2001b). The gull colony had a population index of about 10,000 on a combination of 0.5 ha of grassy field and sparsely vegetated rocky substrate.

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[1] All estimates of gull, heron, and American white pelican populations were provided by David Craig, Willamette University, Salem, Oregon.

[2] Population index is based on a direct count of adult birds on the ground late in the nesting season, resulting in an estimate of breeding pairs (D. Craig, Willamette University, personal communication).

McNary Dam Reservoir—Lake Wallula

Crescent Island (RKm 509) hosted a tern colony of 720 breeding pairs on 0.1 ha of open sand (Collis et al. 2001b). Crescent Island also hosted a gull colony which has not had a population count, but we estimated at least several hundred breeding pairs. Badger Island (RKm 512) hosted an American white pelican colony with a population index of about 200 on 0.1 ha of shrubbery and sand. Foundation Island (RKm 519) hosted cormorant and heron colonies with population indices of about 400 and 200, respectively in 0.2 ha of deciduous trees. Due to the two colonies being intermixed within the trees, and our previous experience of detecting insignificant number of PIT tags from heron colonies (Ryan et al. 2002), all the tags from Foundation Island were identified as cormorant tags in 2001. Richland Island (RKm 545) and Island 18 (RKm 549) hosted gull colonies with population indices of about 19,000 and 12,000 on 1.0 and 0.5 ha of cobble, respectively.

Potholes Reservoir

Solstice Island is a small sand island in Potholes Reservoir approximately 40 km from the Wanapum Reservoir in the Columbia River, which hosted a tern colony with a population index of about 400 on 0.05 ha of open sand (Collis et al. 2001b).

METHODS

We sampled Caspian tern, double-crested cormorant, and gull colonies that had 50 or more nesting pairs, and that therefore had the potential to impact juvenile salmonid populations in the Columbia River Basin (Ryan et al. 2001). Smaller colonies of American white pelican and heron were sampled because logistics permitted sampling with minimal cost. During the spring nesting season (April-July), NMFS, Oregon State University, and Columbia River Inter-Tribal Fish Commission researchers established the boundaries of piscivorous bird colonies for each species by location and number of nesting birds.

PIT tags were detected on bird colonies using two types of PIT-tag detectors. The first was a flat-plate detector, passed over the surface of abandoned colonies with a four-wheel-drive vehicle; the second was a pole-mounted detector, passed by hand over nest areas inaccessible to the vehicle (Ryan et al. 2001).

Detection efficiency was evaluated by distributing PIT tags with known codes on colonies prior to the nesting season and then calculating the percentage of these tags detected at the end of the nesting season. Three hundred PIT tags were distributed on

each of the following islands: East Sand, Little Miller, Foundation, Richland, and Island 18, while 150 PIT tags were distributed on Little Memaloose, Three Mile Canyon, and Crescent Islands. PIT tags were not distributed on Rice, Badger, or Solstice Islands due to the uncertainty of the nesting location prior to nesting season. Tag-reading depths for the flat plate antennas were evaluated on the East Sand Island tern colony at 0-, 2.5-, 5-, and 7.5-cm according to the protocol in Ryan et al. (2001).

In addition, researchers from Biomark used manual sifting techniques to recover PIT tags from Crescent Island after we had completed our detection efforts (Dare et al. 2002). We used Biomark's recovery efforts as an additional evaluation of our detection efficiency by calculating the percentage of tags they recovered that were missed during our detection effort.

In the spring of 2001, we PIT tagged approximately 9,000 fall and spring chinook salmon and steelhead *Oncorhynchus mykiss* (about 3,000 of each type) and released them to rivers that discharge directly into the Columbia River estuary. Juveniles were tagged according to PIT-tagging protocols and standards outlined in the PIT Tag Marking Procedures Manual (CBFWA 1999), using mass marking and simple PIT-tag injectors. Following tagging, fish were held at the hatcheries for a minimum of 7 days to remove any tagging mortalities and rejected tags.

Fall chinook salmon were tagged and released from Sea Resources hatchery on the Chinook River, 6 km upstream from where it enters the Columbia River. Spring chinook were released from net-pens in Deep River, 2 km upstream from where it enters the Columbia River at RKm 35. For tagging purposes, spring chinook were moved to Grays River hatchery where they were tagged and held in a raceway for a minimum of 7 days before being returned to the Deep River net-pens. Steelhead were tagged and released from the Elochoman hatchery, on the Elochoman River, 19 km upstream from its confluence with the Columbia River at RKm 58. A chi-square test of homogeneity of detection rates was used between estuarine salmonid stocks and their cohorts at Bonneville Dam.

RESULTS

In 2001, we detected 49,283 juvenile salmonid PIT tags from piscivorous bird colonies in the Columbia River Basin. In addition, Biomark recovered 948 tags from Crescent Island, increasing the total to 50,231. Of these tags 45,065 were among the 1,099,291 salmonids PIT tagged and released into the Columbia River Basin for the 2001 migration year (4.1% of all salmonids). By species, tags detected on colonies accounted for 3.4% of the chinook salmon, 4.8% of the coho salmon *O. kisutch*, 8.7% of the steelhead, and 2.6% of the sockeye salmon *O. nerka* (Table 1). The majority of these tags were detected on colonies in the Columbia River estuary and McNary Dam Reservoir, where there are large colonies of terns and cormorants (Table 2).

Of the PIT-tagged juvenile salmonids that migrated in-river and were detected at Bonneville Dam (the first impoundment upstream from the Columbia River estuary) in 2001, 12,847 originated from the Snake River Basin (SRB), while 34,384 came from other areas in the Columbia River Basin. Of the 12,487 SRB salmonids detected at Bonneville Dam, the percentages subsequently detected on piscivorous bird colonies in the Columbia River estuary ranged from 6.1% for fall chinook salmon to 24.2% for steelhead (Table 3). Of the 34,384 non-SRB salmonids detected at Bonneville Dam the percentages subsequently detected on piscivorous bird colonies in the Columbia River estuary ranged from 2.3 for fall chinook salmon to 13.4% for coho salmon.

In addition to PIT-tagged salmonids that migrated in-river, 168,734 PIT-tagged salmonids were barged around the FCRPS and released approximately 10 km downstream from Bonneville Dam. Percentages of these salmonids that were subsequently detected on piscivorous bird colonies in the Columbia River estuary ranged from 2.0% for chinook salmon of unknown run-type to 9.3% for coho salmon (Table 4). The proportions detected on colonies were generally lower for barged fish than for in-river migrants detected at Bonneville Dam for both SRB and non-SRB salmonids.

Table 1. Total number of PIT tags released into the Columbia River Basin by migration year and percentages of these tags detected on piscivorous bird colonies. Land-based detection did not begin until 1998, and the lower percentages for detections from earlier years may be a result of tags being swept off the colonies during winter storms.

Migration	Unknown		Chinook		Coho		Steelhead		Sockeye		Total	
Year	(n)	(%)	(n)	(%)	(n)	(%)	(n)	(%)	(n)	(%)	(n)	(%)
1987	12,997	0.1	7,755	0.1			5,166	0.4	1,934	0.1	27,852	0.2
1988	7,793	0.3	19,849	0.2			17,029	0.8	145	0.0	44,816	0.5
1989	2,137	0.5	88,040	0.2			32,335	0.8	3,979	0.1	126,491	0.4
1990			73,754	0.1	3	0.0	23,659	0.9	7,441	0.1	104,857	0.3
1991			79,530	0.2	6,040	0.6	23,286	0.7	8,578	0.1	117,434	0.3
1992			72,144	0.3	4,455	1.1	29,514	0.9	12,400	0.1	118,513	0.5
1993			132,464	0.4	5	20.0	34,543	2.3	33,440	0.1	200,452	0.7
1994			242,388	1.1			143,185	2.7	3,884	0.3	389,457	1.6
1995			478,488	1.1	10	20.0	80,499	3.5	8,134	0.4	567,131	1.4
1996			333,242	1.5	5,338	1.0	80,391	4.3	16,347	0.6	435,318	2.0
1997			440,354	1.5	47,359	4.2	127,003	6.8	4,267	0.8	618,983	2.8
1998			768,025	1.8	76,009	4.7	85,250	11.5	21,108	1.0	950,392	2.9
1999	2	0.0	1,080,387	2.1	60,960	4.4	353,659	9.4	13,243	1.4	1,508,251	3.9
2000	2,338	0.2	936,569	2.7	95,272	4.2	241,217	9.9	8,707	1.7	1,284,103	4.2
2001	6	0.0	915,326	3.4	47,356	4.8	130,654	8.7	5,955	2.6	1,099,297	4.1
Total	25,273	0.2	5,668,315	2.0	342,807	4.3	1,407,390	7.0	149,562	0.6	7,593,347	3.0

Table 2. Migration year 2001 salmonid PIT tags detected on piscivorous bird colonies in the Columbia River Basin.

Detection location	Tern (n)	Cormorant (n)	Gull (n)	Pelican (n)	Heron/ Egret (n)	Total (n)
Columbia River Estuary						
East Sand Island	16,838	3,937				20,775
Rice Island		283				283
Dalles Dam Reservoir						
Little Memaloose Isl			247			247
Little Miller Island			2,395			2,395
John Day Dam Reservoir						
Three Mile Canyon Isl	11		400			411
McNary Dam Reservoir						
Crescent Island	13,258		1,406			14,664
Badger Island				196		196
Foundation Island		2,255				2,255
Richland Island			1,402			1,402
Island 18			664		41	705
Potholes Reservoir						
Solstice Island	1,732					1,732
Total	31,839	6,475	6,514	196	41	45,065

Table 3. PIT-tagged Snake River Basin (SRB) and non-SRB salmonids detected at Bonneville Dam and the percentage of these tags detected on piscivorous bird colonies in the estuary, 2001.

	Bonneville Dam* (n)	East Sand Island		Rice Island	
		Tern (%)	Cormorant (%)	Cormorant (%)	**Total (%)**
		SRB salmonids			
Spring/summer chinook	8,977	9.3	0.7	0.1	**10.1**
Fall chinook	772	4.3	1.6	0.3	**6.2**
Unknown chinook	2285	10.7	0.9	0.2	**11.8**
Steelhead	813	23.1	0.9	0.2	**24.2**
Total	12,847	10.1	0.8	0.1	**11.0**
		Non-SRB salmonids			
Spring/summer chinook	27,045	4.2	0.9	0	**5.1**
Fall chinook	5140	1.4	0.8	0.2	**2.4**
Unknown chinook	351	8.3	0.9	0.3	**9.5**
Steelhead	1218	9.5	0.8	0.0	**10.3**
Coho	500	12.0	1.2	0.2	**13.4**
Sockeye	130	6.2	1.5	0.0	**7.7**
Total	**34,384**	**4.1**	**0.9**	**0.1**	**5.1**

* Species with less than 100 detections at Bonneville are not reported.

Table 4. PIT-tagged salmonids barged downstream from Bonneville Dam and the percentage of these tags detected on piscivorous bird colonies in the estuary, 2001.

		East Sand Island		Rice Island	
Species	Barged (n)	Tern (%)	Cormorant (%)	Cormorant (%)	**Total (%)**
Spring/summer chinook	81,873	3.5	0.8	0.0	**4.3**
Fall chinook	51,982	1.2	1.1	0.1	**2.4**
Unknown chinook	17,297	1.2	0.8	0.0	**2.0**
Steelhead	17,459	6.3	1.1	0.1	**7.5**
Coho	75	9.3	0.0	0.0	**9.3**
Sockeye	48	0.0	2.1	0.0	**2.1**
Total	**168,734**	**2.8**	**0.9**	**0.1**	**3.8**

We also PIT-tagged and released an additional 8,754 salmonids for the 2001 migration year into rivers that discharge directly into the Columbia River estuary. From these releases, we detected tags on estuarine bird colonies in respective percentages of 15.9, 8.4, and 3.7% for fall chinook, steelhead, and spring chinook salmon (Table 5). Spring chinook salmon and steelhead released downstream from Bonneville Dam were detected at rates significantly lower than their cohorts detected at Bonneville Dam ($\chi^2 = 34.4$, $P < 0.001$ for spring chinook; $\chi^2 = 79.5$, $P < 0.001$ for steelhead; Table 6). However, detections of fall chinook released below the dam were significantly higher than those of their upriver counterparts ($\chi^2 = 495.4$, $P < 0.001$).

Outside of the Columbia River estuary, McNary Dam reservoir had the second highest number of PIT tags detected on piscivorous bird colonies (Table 2). There were 48,779 juvenile spring/summer chinook salmon and 15,486 steelhead from migration year 2001 detected at Lower Monumental Dam, the furthest downstream detection facility on the Snake River and the first detection facility upstream from McNary Dam. Of these salmonids, 13.0% of the steelhead and 4.1% of the spring chinook salmon were detected on the Crescent Island tern colony (hatchery and wild fish combined). Steelhead detection rates on Crescent Island were 6 to 10 times higher than in the previous three years, while chinook detection rates were 3 to 8 times higher (Table 7).

Detection efficiencies based on our distributed tags ranged from 6 to 95% depending on colony and detection method (Table 8). Mean detection efficiencies for the flat-plate antennas and for the pole mounted antennas were 53.6 and 41.3%, respectively. While our tag detection efficiency on Crescent Island was low (44.7%), tag recovery efforts conducted by Biomark after our detection effort recovered 11,498 with 5.8% previously undetected. Tag-reading depth efficiencies for the flat-plate antennas were 100, 100, 97.3, and 91.2% at depths of 0-, 2.5-, 5-, and 7.5-cm, respectively.

Table 5. PIT tagged salmonids released into estuarine rivers downstream from Bonneville Dam and the percentage of these tags detected on piscivorous bird colonies in the estuary, 2001.

Species	Release site	Release number	East Sand Island Tern (%)	East Sand Island Cormorant (%)	Rice Island Cormorant (%)	**Total (%)**
Spring chinook	Deep River	2,953	2.0	1.7	0.0	**3.7**
Fall chinook	Chinook River	2,888	4.6	11.1	0.2	**15.9**
Steelhead	Elochoman R.	2,913	7.0	1.2	0.2	**8.4**

Table 6. PIT-tagged salmonids detected at Bonneville Dam and the percentage of these tags detected on piscivorous bird colonies in the estuary, 2001.

Species	Bonneville (n)	East Sand Island Tern (%)	East Sand Island Cormorant (%)	Rice Island Cormorant (%)	**Total (%)**
Spring/summer chinook	36,022	5.5	0.9	0.1	**6.4**
Fall chinook	5,912	1.8	0.9	0.2	**2.8**
Unknown chinook	2,636	10.4	0.9	0.2	**11.4**
Steelhead	2,031	15.0	0.8	0.1	**15.9**
Coho	501	12.0	1.2	0.2	**13.4**
Sockeye	144	7.6	1.4	0.0	**9.0**
Total	47,246	5.8	0.9	0.1	**6.7**

Table 7. PIT-tagged salmonids detected at Lower Monumental Dam and the percentage of these salmonids detected on the Crescent Island tern colony by migration year.

Migration year	Spring/summer chinook				Steelhead				Crescent Island population index
	Hatchery		Wild		Hatchery		Wild		
	(n)	(%)	(n)	(%)	(n)	(%)	(n)	(%)	(n)*
1998	49,317	0.4	8,194	0.4	18,086	4.3	5,145	1.9	698
1999	113,689	0.7	21,135	0.7	38,687	4.4	8,229	3.0	999
2000	5,578	0.4	13,513	0.4	9,752	2.5	16,784	1.3	600
2001	38,309	4.4	10,470	3.2	9,135	12.3	6,351	14.0	720

	Combined spring/summer chinook		Combined steelhead	
	(n)	(%)	(n)	(%)
2001	48,779	4.1	15,486	13.0

* Direct count of adult terns late in the nesting season, resulting in an estimate of breeding pairs.

Table 8. Detection efficiency of PIT tags distributed on colonies prior to the nesting season.

Detection Location	Gull (%)	Tern (%)	Cormorant (%)
East Sand Island		95.3	45.3
Little Memaloose Island	76.7		
Little Miller Island	48.7		
Three Mile Canyon Island	44.0	6.0	
Crescent Island		44.7	
Foundation Island			65.3
Richland Island	37.3		
Island 18	37.0		
Total	45.8	60.3	55.3

DISCUSSION

The 50,231 juvenile salmonid PIT tags detected in 2001 resulted in a total of nearly 230,000 PIT tags detected on piscivorous bird colonies in the Columbia River Basin since 1998. While 230,000 PIT tags seems like a large number, these tags represent a minimum estimate of avian predation since our sampling effort only covers a portion of the area where tags can be deposited, and detection efficiency is less than 100%.

Detections of PIT tags on the tern colonies of Crescent and East Sand Islands in 2001 indicated a large increase in the proportion of PIT tags from juvenile salmonids deposited on both islands compared with previous years. The greatest increase was in the proportion of PIT tags detected on Crescent Island, and was most likely due to the record low water flow and lack of spill.

The low flow prompted fisheries managers to maximize the number of fish collected at Snake River Dams and transported around the FCRPS by reducing spill. This left fewer juvenile salmonids in the river to migrate past Crescent Island compared to previous years, and resulted in the terns consuming a higher proportion of the available salmonids. In addition, terns are surface predators (Cuthbert and Wires 1999), and the less turbid conditions created by low river flows may have benefitted foraging terns.

The increase in proportion of PIT tags detected on East Sand Island may also be due to the low river flow which resulted in slower migration speeds below Bonneville Dam (R. Ledgerwood, NMFS, personal communication). Additional time spent migrating through the estuary may have increased the period during which salmonids were available for avian predation.

The predation rate on SRB salmonids in the Columbia River estuary was surprisingly higher than the predation rate on non-SRB salmonids. While we do not have any substantial evidence as to why this is occurring, we intend to further investigate this increased vulnerability and monitor whether this pattern continues for future migration years. One area that we intend to investigate is the speculation that SRB juvenile salmonids, which migrate through more than one Snake River Dam bypass system, have lower smolt to adult return rates (Budy et al. 2002), and how this may relate to increased vulnerability to avian predation.

We expanded our research to obtain additional data on salmonids released directly into the Columbia River estuary. These data provide preliminary evaluations of the vulnerability of salmonids to avian predation from three rivers that discharge directly into the estuary. We observed a high predation rate on fall chinook salmon, which may have resulted from having to pass through a small channel between Sand and East Sand Islands, where 7,000 nesting pairs of cormorants were concentrated. Had the fall chinook been

released from a site to enter the estuary at a different location, detection rates may have been reduced. We plan to expand this effort in 2002 with additional release sites.

PIT-tag data collected from piscivorous bird colonies throughout the Columbia River Basin continue to provide estimates of relative vulnerability to avian predation and data that can be used to evaluate relocation efforts in the Columbia River estuary (Collis et al. 2001a; Ryan et al. 2003). In addition, these data are stored on a central database allowing researchers to remove known mortalities from their data sets producing a more accurate set of data that can be used for many purposes, such as estimating survival past dams (Absolon et al. 2002).

While we have not developed a method to evaluate the rate at which tags are deposited on the sampled sites, we have evaluated detection efficiency of tags known to be deposited on a colony. Evaluations of detection efficiency on the East Sand Island tern colony suggest over 90% of all the tags deposited on the colony in both 2000 and 2001 were detected. In contrast, our detection efficiency averaged around 40% for all colonies, and we would extrapolate our detection numbers based on this if these were the only data available.

However, manual recovery of tags by researchers from Biomark on Crescent Island resulted in 11,498 in-river migrant tags of which only 5.8% were undetected by our detection efforts. This suggests that while our detection efficiency is probably greater than 40% it is still not 100%. Therefore, our sampling efforts continue to provide minimum estimates of predation.

REFERENCES

Absolon, R. F., E. M. Dawley, B. P. Sandford, J. W. Ferguson, and D. A. Brege. 2002. Relative survival of juvenile salmon passing through the spillway of The Dalles Dam, 1997-2000. Report of the National Marine Fisheries Service to the U.S. Army Corps of Engineers, Portland, Oregon.

Budy, P., P. G. Thiede, N. Bouwes, C. E. Petrosky, Schaller, H. 2002. Evidence linking delayed mortality of Snake River salmon to their earlier hydrosystem experience. North American Journal of Fisheries Management 22:35-51.

Carter, H. R., A. L. Sowls, M. S. Rodway, U. W. Wilson, R. W. Lowe, G. J. McChesney, F. Gress, and D. W. Anderson. 1995. Population size, trends and conservation problems of the double-crested cormorant on the Pacific Coast of North America. Pages 189-215 in D. N. Nettleship and D. C. Duffy, editors. The double-crested cormorant: biology, conservation and management. Colonial Waterbirds 18 (Special Publication1): 189-215.

Collis, K., D. D. Roby, D. P. Craig, B. A. Ryan, and R. D. Ledgerwood. 2001a. Colonial waterbird predation on PIT-tagged juvenile salmonids in the Columbia River Estuary: Vulnerability of different salmonid species, stocks, and rearing types. Transactions of the American Fisheries Society 130:385-396.

Collis, K., D.D. Roby, D.E.Lyons, and D.P. Craig. 2001b. Draft 2001 season summary: Columbia Bird Research update. Available www.columbiabirdresearch.org (July 2001).

CBFWA (Columbia Basin Fish and Wildlife Authority PIT Tag Steering Committee). 1999. PIT Tag Marking Procedures Manual. Version 2.0.

Cuthbert, F., and L. Wires. 1999. Caspian tern (*Sterna caspia*). Pages 1-32 in A. Poole and F. Gill, editors. The Birds of North America, no.403. The Birds of North America, Inc., Philadelphia.

Dare, R. M., McCutcheon C. S., and Richmoond R.J. 2002. Manual PIT tag collection at the Caspian tern colony on Crescent Island, Washington. Biomark, Inc. Report to the U.S. Army Corps of Engineers, Walla Walla, Washington.

Gill, R. E. Jr., and L. R. Mewladt. 1983. Pacific coast Caspian terns: dynamics of an expanding population. The Auk 100:369-381.

Kareiva, P., M. Marvier, and M. McClure. 2000. Recovery and management options for spring/summer chinook salmon in the Columbia River Basin. Science 290:977-979.

NMFS (National Marine Fisheries Service). 2000. Biological opinion: reinitiation of consultation on the Federal Columbia River Power System, including the juvenile fish transportation system, and 19 Bureau of Reclamation projects in the Columbia Basin. (Available from NMFS Northwest Region, Hydro Program, 525 NE Oregon Street, Suite 500, Portland OR 97232.)

Prentice, E. F., T. A. Flagg, and C. S. McCutcheon. 1990a. Feasibility of using implantable passive integrated transponder (PIT) tags in salmonids. American Fisheries Society Symposium 7:317-322.

Prentice, E. F., T. A. Flagg, C. S. McCutcheon, and D. F. Brastow. 1990b. PIT-tag monitoring systems for hydroelectric dams and fish hatcheries. American Fisheries Society Symposium 7:323-334.

PSMFC (Pacific States Marine Fisheries Commission). 1996--. Columbia Basin PIT tag information system (PTAGIS). Pacific States Marine Fisheries Commission, Gladstone, Oregon. Online database. (Available through Internet, http://www.psmfc.org/pittag/)

Reimers, P. E. 1973. The length of residence of juvenile fall chinook in Sixes River, Oregon. Fisheries Commission of Oregon Research Report 4(2):1-43.

Ryan, B. A., J. W. Ferguson, R. D. Ledgerwood, and E. P. Nunnallee. 2001. Detection of passive integrated transponder tags from juvenile salmonids on piscivorous bird colonies in the Columbia River Basin. North American Journal of Fisheries Management 21:149-153.

Ryan, B. A., J. H. Glabek, J. W. Ferguson, E. P. Nunnallee, and R. D. Ledgerwood. 2002. Detection of passive integrated transponder tags on piscivorous bird colonies in the Columbia River Basin, 2000. Report of the National Marine Fisheries Service to the U.S. Army Corps of Engineers, Walla Walla, Washington.

Ryan, B. A., S.G. Smith, J. M. Butzerin, and J. W. Ferguson. 2003. Relative vulnerability to avian predation of juvenile salmonids tagged with passive integrated transponders in the Columbia River Estuary, 1998-2000. Transactions of the American Fisheries Society 132:275-288.

USACE (U.S. Army Corps of Engineers). 2001. Environmental assessment: Caspian tern relocation FY 2001-2002 management plan and pile dike modification. U.S. Army Corps of Engineers, Portland, Oregon.

Waples, R. S. 1991. Pacific salmon, *Oncorhynchus* spp., and the definition of "species" under the Endangered Species Act. Marine Fisheries Review 53(3):11-22.

APPENDIX

Appendix Table A1. Migration year 2001 juvenile spring/summer chinook PIT tags released into the Columbia River Basin. Separated by hatchery, wild, and unknown rear types.

Release site[a]	Release code[b]	Hatchery (n)	Wild (n)	Unknown (n)
American River	AMERR		119	
Bear Valley Creek	BEARVC		581	
Big White Salmon Ponds	BIGWSP	1,947		
BO2 - Release into Gatewell(s)	BO2GWL			1,909
Brushy Fork Creek	BRUSHC		1	
Carson NFH	CARS	14,980		
Catherine Creek	CATHEC	404	1,862	
Catherine Creek Pond	CATHEP	20,915		
Crooked Fork Creek Trap	CFCTRP		468	
Chandler Canal	CHANDL	895	1,606	
Clark Flat Acclimation Pond	CLARFP	13,281		
Clearwater River	CLWR	55,142	1	
Columbia River	COLR	113,336		100
Colt Creek	COLTKC		48	
Crooked River Pond	CROOKP	799		
Crooked River Trap	CROTRP	125	73	
Cunningham Slough	CUNNSL	369		
Deep River Net Pens (Deep River, Washington)	DRNP	2,953		
Easton Acclimation Pond	EASTOP	13,280		
Elk Creek	ELKC		44	
Fish Creek Trap	FISTRP	4	405	
Grande Ronde River Pond	GRANDP	495		
Grande Ronde River	GRANDR	1,628	730	
Hard Creek	HERDC		311	
Imnaha River	IMNAHR		1,000	
Imnaha River Weir	IMNAHW	20,922	1,858	
Imnaha Trap	IMNTRP	3,008	12,014	
Imeques Acclimation Pond	IMQP	2,911		
Jack Creek Acclimation Pond	JACKCP	13,237		
John Day River	JDAR		3,449	
Middle Fork John Day River	JDARMF		155	
North Fork John Day River	JDARNF		287	
Johnson Creek	JOHNSC		677	
Johnson Creek Trap	JOHTRP		5,626	
Knox Bridge	KNOXB	55,729		
Kooskia National Fish Hatchery	KOOS	749		

Appendix Table A1. Continued.

Release site	Release code	Hatchery (n)	Wild (n)	Unknown (n)
Lake Creek	LAKEC		2,728	
Leaburg Dam - Release into the Facility Bypass Flume/Pipe	LEABYP	5	3,950	
Leavenworth National Fish Hatchery	LEAV	7,580		
Lemhi River	LEMHIR		700	
Lemhi River Weir	LEMHIW		1,591	
Lolo Creek	LOLOC	1,066	1,396	
Lookingglass Creek	LOOKGC	1,501	3	
Lostine River Pond	LOSTIP	7,885		
Lostine River	LOSTIR	501	1,940	
Lower South Fork Salmon River Trap	LSFTRP	68		
Marsh Creek Trap	MARTRP		97	
McKenzie Hatchery	MCKE	997		
McKenzie River	MCKER		1,898	
Meacham Creek	MEACHC		125	
Meadow Creek	MEADOC	21	729	
Minam River	MINAMR		1,836	
Multnomah Channel, Columbia River	MULTCH	165		
Newsome Creek	NEWSOC	1,059	23	
Pahsimeroi Pond	PAHP	1,000		
Pahsimeroi River	PAHTRP	3	2,307	
Powell Rearing Pond	POWP	997		
Rapid River Hatchery	RAPH	55,091		
Red River Rearing Pond	REDP	500		
Red River Trap	REDTRP	58	550	
Rock Island Dam	RIS	45,010		
Redfish Lake Creek Trap	RLCTRP		1	
Rosa Dam	ROSAD	1,435	2,179	
Rocky Reach Dam	RRE	45,108		
South Fork Salmon River	SALRSF	2,051	1,010	
Sawtooth Hatchery	SAWT	500		
Sawtooth Trap	SAWTRP		1,574	
Secesh River	SECESR		4,232	
South Fork Salmon River Trap	SFSTRP	195	1,954	2

Appendix Table A1. Continued.

Release site	Release code	Hatchery (n)	Wild (n)	Unknown (n)
Slate Creek	SLATEC		6	
Squaw Creek (Umatilla River)	SQAWC		4	
Squaw Creek	SQUAWC		2	
Stolle Pond	STOLP	598	2	
Tenmile Creek	TENMIC		1	
Tucannon River	TUCR	301	158	
Umatilla River	UMAR	739	1,547	
Valley Creek	VALEYC		1,004	
Wells Hatchery	WELH	6,000		
White Sand Creek - Replaced by COLTKC	WHITSC		16	
Willamette River	WILLR		941	
Winthrop National Fish Hatchery	WINT	7,423		
Yakima River	YAKIMR	1,495	2,614	
Total		**526,461**	**68,433**	**2,011**

a. Release sites from the PIT Tag Information System specification document.
b. Release site codes from the PIT Tag Information System specification document.

Appendix Table A2. Migration year 2001 juvenile fall chinook PIT tags released into the Columbia River Basin. Separated by hatchery, wild, and unknown rear types.

Release site[a]	Release code[b]	Hatchery (n)	Wild (n)	Unknown (n)
Big Canyon Facility	BCANF	807		1,974
Big Canyon Creek Acclimation Facility (Clearwater River)	BCCAP	34,644		375
BO1 - Release into the Facility Bypass Flume/Pipe	BO1BYP	257		
BO1 - Release into Gatewell(s)	BO2GWL			
Chandler Canal	CHANDL	3,979	201	
Captain John Rapids Acclimation Pond	CJRAP	4,516		
Columbia River	COLR	29,759	10,012	
LGR - Release into the PIT-Tag Diversion System between the Diversion Gate and the furthest downstream PIT-Tag Detector	LGRBPS	12		261
LGR - Release into the PIT-Tag Diversion System downstream from the Last PIT-Tag Detector	LGROFL	12		23,250
Lyons Ferry Hatchery	LYFE	991		38,546
MCN - Release into Gatewell(s)	MCNGWL			
MCN - Release below the PIT-Tag Diversion System Gate with subsequent Barge Transportation from the Facility	MCNRBR			
MCN - Release below the PIT-Tag Diversion System Gate with subsequent Return to the River at the Facility	MCNRRR			
Pittsburg Landing Acclimation Facility	PLAP	16,268		
Priest Rapids Hatchery	PRDH	2,997		
Ringold Hatchery	RINH	3,006		
Sea Resources Hatchery (Chinook River, Washington)	SERH	2,879		
Snake River	SNAKER	81,785		
Snake Trap	SNKTRP	5		
Thornhollow Acclimation Pond	THOP	1,147		739
Tucannon River	TUCR		419	
Umatilla River	UMAR	4,350		
Yakima River	YAKIMR	1,020	224	
Total		**188,434**	**10,856**	**65,145**

a. Release sites from the PIT Tag Information System specification document.

b. Release site codes from the PIT Tag Information System specification document.

Appendix Table A3. Migration year 2001 juvenile unknown chinook PIT tags released into the Columbia River Basin. Separated by hatchery, wild, and unknown rear types.

Release site[a]	Release code[b]	Hatchery (n)	Wild (n)	Unknown (n)
Clearwater River	CLWR		32	460
Ice Harbor Dam	IHR	851		
LGR - Release into the PIT-Tag Diversion System between the Diversion Gate and the furthest downstream PIT-Tag Detector	LGRBPS	190		
LGR - Release into the PIT-Tag Diversion System downstream from the Last PIT-Tag Detector	LGROFL	162		
LGR - Release below the PIT-Tag Diversion System Gate with subsequent Barge Transportation from the Facility	LGRRBR	99	17,565	
Pittsburg Landing Acclimation Facility	PLAP	4		
Rock Island Dam	RIS	1,830		4,491
Rocky Reach Dam	RRE	3,148	31	1,178
Salmon Trap	SALTRP	4,279	1,844	
Snake River	SNAKER	15,589	1,392	
Snake Trap	SNKTRP	381	35	
Umatilla River	UMAR		348	
Total		**26,533**	**21,247**	**6,129**

a. Release sites from the PIT Tag Information System specification document.
b. Release site codes from the PIT Tag Information System specification document.

Appendix Table A4. Migration year 2001 juvenile steelhead PIT tags released into the Columbia River Basin. Separated by hatchery, wild, and unknown rear types.

Release site[a]	Release code[b]	Hatchery (n)	Wild (n)	Unknown (n)
American River	AMERR	295	48	
Bargamin Creek	BARGAC		514	
Big Canyon Facility	BCANF	2,069		
Bear Valley Creek	BEARVC		205	
Bedrock Creek	BEDRKC	16		
Big Canyon Creek	BIGCAC	7		
East Fork Birch Creek	BIRCHE		224	
West Fork Birch Creek	BIRCHW		203	
BO1 - Release into the Facility Bypass Flume/Pipe	BO1BYP	253		
Bonifer Springs Acclimation Pond	BONP	2,047		
Boulder Creek	BOULDC		550	
Boulder Creek Trap	BOUTRP		9	
Brushy Fork Creek	BRUSHC		615	
North Fork Catherine Creek	CATCNF		117	
South Fork Catherine Creek	CATCSF		225	
Catherine Creek	CATHEC		1,242	
Crooked Fork Creek Trap	CFCTRP		398	
Chamberlain Creek	CHAMBC		2,707	
Clear Creek	CLEARC	903	110	
Clearwater River	CLWR	4,871		
North Fork Clearwater River	CLWRNF	644		
South Fork Clearwater River	CLWRSF	1,199		
Colt Kill Creek - Replaces WHITSC	COLTKC		145	
Cottonwood Creek	COTNWC	35		
Cottonwood Acclimation Pond	COTP	346		
Crooked River Pond	CROOKP	599		
Crooked River Trap	CROTRP		61	
Dayton Acclimation Pond	DAYP	856		
Deadman Creek	DEADMC		58	
Elk Creek	ELKC		80	
Elochoman River Hatchery (Elochoman River, Washington)	ELRH	1,565		
Fish Creek	FISHC		680	
Fish Creek Trap	FISTRP		5,893	
West Fork Gedney Creek	GEDCWF		165	
Gedney Creek	GEDNEC		568	
Grande Ronde River	GRANDR	2,216	1,144	
Hells Canyon Dam	HCD	300		
Herd Creek	HERDC		31	
Horse Creek	HORSEC		822	

Appendix Table A4. Continued.

Release site[a]	Release code[b]	Hatchery (n)	Wild (n)	Unknown (n)
Imnaha River Weir	IMNAHW		1	
Imnaha Trap	IMNTRP	3,463	3,680	
Jack Creek Acclimation Pond	JACKSC	26		
John Day River	JDAR		433	
North Fork John Day River	JDARNF		1	
Johns Creek	JOHNC		69	
Johnson Creek	JOHNSC		2	
Johnson Creek Trap	JOHTRP		1,549	
Lake Creek	LAKEC		192	
Little Catherine Creek	LCATHC		415	
Lemhi River	LEMHIR	300		
LGR - Release below the PIT-Tag Diversion System Gate with subsequent Barge Transportation from the Facility	LGRRBR	2	15,878	1
LGR - Release below the PIT-Tag Diversion System Gate with subsequent Return to the River at the Facility	LGRRRR	2,222	409	
LGR - Release into the Tailrace within 0.5 km downstream from Dam	LGRTAL	14,690	3,091	
Lolo Creek	LOLOC	318	1,309	
Lookingglass Creek	LOOKGC	3	1,328	
Lostine River	LOSTIR		764	
Little Salmon River	LSALR	900		
Lower South Fork Salmon River Trap	LSFTRP		269	
Little Sheep Facility	LSHEEF	747		
Lyons Ferry Hatchery	LYFE	344		
Marsh Creek	MARSHC		227	
Marsh Creek Trap	MARTRP		134	
Meacham Creek	MEACHC		989	
Meadow Creek	MEADOC		46	
Minam River	MINAMR	2	485	
Minthorn Acclimation Pond	MINP	4,127		
Newsome Creek	NEWSOC	300	589	
O'Hara Creek	OHARAC		703	
Pahsimeroi River Trap	PAHTRP	302	1,144	
Panther Creek (trib. to Wind River, Wash.)	PANT2C		23	
Potlatch River	POTR		85	
Red River Rearing Pond	REDP	299		
Red River Trap	REDTRP		82	1
Rock Island Dam	RIS	2,829	1,198	
Rocky Reach Dam	RRE	1,200		
East Fork Salmon River Trap	SALEFT	300		
Salmon River	SALR	1,600		
South Fork Salmon River	SALRSF		60	

Appendix Table A4. Continued.

Release site[a]	Release code[b]	Hatchery (n)	Wild (n)	Unknown (n)
Salmon Trap	SALTRP	3,147	478	
Sawtooth Hatchery	SAWT	500		
Sawtooth Trap	SAWTRP		321	
Secesh River	SECESR		568	
South Fork Salmon River Trap	SFSTRP		213	
Slate Creek	SLATEC		970	
Snake River	SNAKER	1		
Snake Trap	SNKTRP	3,129	876	
Squaw Creek (Umatilla River)	SQAWC		104	
Squaw Creek	SQUAWC	300	157	
Squaw Creek Acclimation Pond	SQUAWP	900		
Storm Creek	STORMC		404	
Tenmile Creek	TENMIC		69	
Trout Creek (trib. to Wind River, Wash.)	TROUTC		47	
Tucannon River	TUCR	1,024	333	
Umatilla River	UMAR	6,983	1,225	
Valley Creek	VALEYC		88	
Wallowa Hatchery	WALH	890		
Whitebird Creek	WBIRDC		1,104	
White Sand Creek - Replaced by COLTKC	WHITSC		84	
Wind River, Washington	WIND2R		289	
West Fork Yankee Fork	YANKWF	297		
Total		**69,366**	**59,299**	**2**

a. Release sites from the PIT Tag Information System specification document.
b. Release site codes from the PIT Tag Information System specification document.

Appendix Table A5. Migration year 2001 juvenile coho PIT tags released into the Columbia River Basin. Separated by hatchery, wild, and unknown rear types.

Release site[a]	Release code[b]	Hatchery (n)	Wild (n)	Unknown (n)
Chandler Canal	CHANDL			982
Columbia River	COLR			101
Eldorado Creek	ELDORC	1,554		
Lapwai Creek	LAPC	1,035		
Leavenworth National Fish Hatchery	LEAV	8,840		
LGR - Release below the PIT-Tag Diversion System Gate with subsequent Barge Transportation from the Facility	LGRRBR		8	
Lolo Creek	LOLOC	708		
Meadow Creek	MEADOC	1,447		
Natches River	NATCHR	9,957		
Pendelton Acclimation Pond	PENP	1,178		
Potlatch River	POTR	1,042		
Rock Island Dam	RIS			1
Rocky Reach Dam	RRE	223		
Snake Trap	SNKTRP			1
Umatilla River	UMAR		251	755
Winthrop National Fish Hatchery	WINT	8,000		
Yakima River	YAKIMR	9,827		1,113
Total		**43,811**	**259**	**2,953**

a. Release sites from the PIT Tag Information System specification document.
b. Release site codes from the PIT Tag Information System specification document.

Appendix Table A6. Migration year 2001 juvenile sockeye PIT tags released into the Columbia River Basin. Separated by hatchery, wild, and unknown rear types.

Release site[a]	Release code[b]	Hatchery (n)	Wild (n)	Unknown (n)
Alturas Lake Creek	ALTULC	385	174	2
Pettit Lake Creek	PETTLC	273	1	
Redfish Lake Creek	REDFLC	1,002		
Rock Island Dam	RIS	53	546	
Redfish Lake Creek Trap	RLCTRP	1,387	37	
Rocky Reach Dam	RRE		1,998	
Sawtooth Trap	SAWTRP	35		
Total		**3,135**	**2,756**	**2**

a. Release sites from the PIT Tag Information System specification document.
b. Release site codes from the PIT Tag Information System specification document.

Appendix Table B1. Migration year 2001 juvenile spring/summer chinook PIT tags detected on the East Sand Island cormorant colony, separated by hatchery, wild, and unknown rear types.

	Spring/summer chinook				Spring/summer chinook (cont.)		
	Hatchery	Wild	Unknown		Hatchery	Wild	Unknown
Release site*	(n)	(n)	(n)	Release site	(n)	(n)	(n)
BIGWSP	4			PAHTRP		1	
BO2GWL			18	POWP	1		
CARS	85			RAPH	137		
CATHEC	2	1		RIS	205		
CATHEP	42			ROSAD		2	
CHANDL		2		RRE	197		
CLARFP	8			SECESR		3	
CLWR	239			TUCR	1	1	
COLR	758			UMAR	2		
COLTKC		1		WELH	4		
CUNNSL	1			WINT	26		
DRNP	51			YAKIMR	1	7	
EASTOP	9			**Total**	**2,117**	**84**	**18**
GRANDR	3	2					
HERDC		1					
IMNAHW	81	1					
IMNTRP	11	26					
IMQP	7						
JACKCP	14						
JDAR		12					
JDARMF		2					
JOHTRP		6					
KNOXB	186						
LAKEC		1					
LEABYP		7					
LEAV	29						
LEMHIR		1					
LOLOC	2	1					
LOOKGC	5						
LOSTIP	5						
LOSTIR	1	2					
MEACHC		1					
MEADOC		2					
MINAMR		1					

* Release site codes from the PIT Tag Information System specification document.

Appendix Table B2. Migration year 2001 juvenile fall and unknown chinook PIT tags detected on the East Sand Island cormorant colony, separated by hatchery, wild, and unknown rear types.

	Fall chinook				Unknown chinook		
Release Site*	Hatchery (n)	Wild (n)	Unknown (n)	Release Site	Hatchery (n)	Wild (n)	Unknown (n)
BCCAP	31			IHR	6		
BO1BYP	5			LGRRBR	1	132	
BO2GWL			15	RIS	4		2
CHANDL	6	1		RRE	12		
CJRAP	20			SALTRP	7		
COLR	65	10		SNAKER	54	1	
LYFE	4			**Total**	**84**	**133**	**2**
MCNRBR			360				
MCNRRR			145				
PLAP	30						
PRDH	10						
RINH	6						
SERH	320						
SNAKER	176						
THOP	3						
UMAR	7						
YAKIMR	2	2					
Total	**685**	**13**	**520**				

* Release site codes from the PIT Tag Information System specification document.

Appendix Table B3. Migration year 2001 juvenile steelhead, coho, and sockeye PIT tags detected on the East Sand Island cormorant colony, separated by hatchery, wild, and unknown rear types.

	Steelhead				Coho		
Release site*	Hatchery (n)	Wild (n)	Unknown (n)	Release site	Hatchery (n)	Wild (n)	Unknown (n)
AMERR	1			CHANDL			1
BO1BYP	2			NATCHR	6		
BONP	1			PENP	1		
CHAMBC		1		UMAR			4
CLEARC	1			YAKIMR	2		
CLWR	1			**Total**	**9**	**0**	**5**
CLWRSF	1						
DAYP	1						
ELRH	34				Sockeye		
FISTRP		3			Hatchery	Wild	Unknown
GRANDR		1			(n)	(n)	(n)
IMNTRP	4	5		RIS		1	
JDAR		1		RRE		6	
LGRRBR		168		**Total**	**0**	**7**	**0**
LGRTAL	7	1					
LOLOC		1					
LOOKGC		2					
LOSTIR		1					
LSALR	1						
MINP	2						
OHARAC		1					
RIS	1	1					
SALR	2						
SNKTRP		1					
UMAR	12	2					
Total	**71**	**189**	**0**				

* Release site codes from the PIT Tag Information System specification document.

Appendix Table C1. Migration year 2001 juvenile spring/summer chinook PIT tags detected on the East Sand Island tern colony, separated by hatchery, wild, and unknown rear types.

	Spring/summer chinook				Spring/summer chinook (cont.)		
Release site*	Hatchery (n)	Wild (n)	Unknown (n)	Release site	Hatchery (n)	Wild (n)	Unknown (n)
BIGWSP	1			LOSTIR	7	16	
BO2GWL			44	MEACHC		2	
CARS	207			MEADOC		5	
CATHEC	9	2		MINAMR		8	
CATHEP	526			NEWSOC	33		
CFCTRP		2		PAHP	25		
CHANDL	25	34		PAHTRP		5	
CLARFP	137			POWP	8		
CLWR	1,427			RAPH	1,145		
COLR	3,132		4	RIS	1,133		
CROOKP	7			ROSAD	6	12	
CROTRP	1			RRE	1,028		
CUNNSL	1			SALRSF	8	1	
DRNP	58			SAWT	9		
EASTOP	149			SAWTRP		2	
FISTRP		2		SECESR		24	
GRANDP	12			SFSTRP		4	
GRANDR	67	12		TUCR	5	6	
HERDC		4		UMAR	14	11	
IMNAHR		2		VALEYC		1	
IMNAHW	515	7		WELH	3		
IMNTRP	73	160		WINT	215		
IMQP	30			YAKIMR	43	43	
JACKCP	162			**Total**	**11,689**	**445**	**48**
JDAR		18					
JOHNSC		5					
JOHTRP		28					
KNOXB	1,082						
KOOS	17						
LAKEC		10					
LEABYP		5					
LEAV	203						
LEMHIR		2					
LEMHIW		8					
LOLOC	22	4					
LOOKGC	13						
LOSTIP	131						

* Release site codes from the PIT Tag Information System specification document.

Appendix Table C2. Migration year 2001 juvenile fall and unknown chinook PIT tags detected on the East Sand Island tern colony, separated by hatchery, wild, and unknown rear types.

Release site*	Fall chinook			Release site	Unknown chinook		
	Hatchery (n)	Wild (n)	Unknown (n)		Hatchery (n)	Wild (n)	Unknown (n)
BCCAP	71			IHR	41		
BO1BYP	1			LGRBPS	5		
BO2GWL			42	LGROFL	2		
CHANDL	19	4		LGRRBR	1	191	
CJRAP	46			RIS	36		19
COLR	53	4		RRE	77		2
LYFE	22			SALTRP	108	28	
MCNGWL			1	SNAKER	627		
MCNRBR			268	SNKTRP	15		
MCNRRR			85	**Total**	**912**	**219**	**21**
PLAP	102						
PRDH	8						
RINH	10						
SERH	133						
SNAKER	345						
SNKTRP	1						
THOP	4						
UMAR	12						
YAKIMR	7						
Total	**834**	**8**	**396**				

* Release site codes from the PIT Tag Information System specification document.

Appendix Table C3. Migration year 2001 juvenile steelhead PIT tags detected on the East Sand Island tern colony, separated by hatchery, wild, and unknown rear types.

	Steelhead				Steelhead (cont.)		
Release site*	Hatchery (n)	Wild (n)	Unknown (n)	Release site	Hatchery (n)	Wild (n)	Unknown (n)
AMERR	1			LSHEEF	5		
BARGAC		1		LYFE	4		
BCANF	11			MEACHC		9	
BIRCHE		2		MINAMR		2	
BO1BYP	8			MINP	44		
BONP	12			NEWSOC		2	
BRUSHC		6		OHARAC		4	
CATHEC		6		PAHTRP	1	4	
CFCTRP		1		REDP	3		
CHAMBC		6		RIS	29	13	
CLEARC	13	2		RRE	26		
CLWR	48			SALEFT	4		
CLWRSF	17			SALR	11		
COLTKC		1		SALTRP	23	5	
COTNWC	1			SAWT	5		
COTP	1			SAWTRP		1	
CROOKP	3			SLATEC		2	
DAYP	4			SNKTRP	29	8	
DEADMC		1		SQAWC		1	
ELRH	205			SQUAWC	1	1	
FISHC		2		SQUAWP	3		
FISTRP		23		TUCR	12	11	
GEDCWF		1		UMAR	106	32	
GEDNEC		1		WALH	5		
GRANDR	32	7		WBIRDC		2	
HCD	3			WHITSC		1	
HORSEC		2		YANKWF	1		
IMNTRP	42	52		**Total**	**879**	**1,153**	**0**
JDAR		5					
JOHTRP		8					
LEMHIR	1						
LGRRBR		868					
LGRRRR	17	6					
LGRTAL	136	30					
LOLOC		9					
LOOKGC		6					
LOSTIR		8					
LSALR	12						
LSFTRP		1					

* Release site codes from the PIT Tag Information System specification document.

Appendix Table C4. Migration year 2001 juvenile coho and sockeye PIT tags detected on the East Sand Island tern colony, separated by hatchery, wild, and unknown rear types.

	Coho			Release	Sockeye		
Release site*	Hatchery (n)	Wild (n)	Unknown (n)	site	Hatchery (n)	Wild (n)	Unknown (n)
CHANDL			5	ALTULC	3		
CLEARC	1			REDFLC	2		
COLR			1	RIS	1	5	
ELDORC	1			RLCTRP	1		
LEAV	26			RRE		30	
LGRRBR		1		**Total**	**7**	**35**	**0**
LOLOC	1						
NATCHR	90						
PENP	13						
UMAR		1	7				
WINT	12						
YAKIMR	21		12				
Total	**165**	**2**	**25**				

* Release site codes from the PIT Tag Information System specification document.

Appendix Table D1. Migration year 2001 juvenile spring/summer, fall, unknown chinook, steelhead, coho, and sockeye PIT tags detected on the Rice Island cormorant colony, separated by hatchery, wild, and unknown rear types.

Release site*	Spring/summer chinook Hatchery	Wild	Unknown
BIGWSP	1		
BO2GWL			1
CARS	2		
CATHEP	4		
CLARFP	1		
CLWR	9		
COLR	32		
EASTOP	3		
IMNAHW	10		
IMNTRP		1	
IMQP	1		
JACKCP	1		
JDAR		1	
JOHTRP		1	
KNOXB	17		
LAKEC		1	
LEAV	3		
RAPH	17		
RIS	6		
RRE	10		
UMAR		1	
WINT	1		
YAKIMR		2	
Total	**118**	**7**	**1**

	Fall chinook Hatchery	Wild	Unknown
BCCAP	4		
BO1BYP	2		
BO2GWL			5
COLR	4	1	
LYFE	1		
MCNRBR			51
MCNRRR			19
RINH	1		
SERH	6		
SNAKER	9		
TUCR		1	
Total	**27**	**2**	**75**

Release site	Unknown chinook Hatchery	Wild	Unknown
IHR	1		
LGRRBR		9	
RRE	2		
SALTRP	2		
SNAKER	6		0
Total	**11**	**9**	**0**

	Coho Hatchery	Wild	Unknown
NATCHR	1		
YAKIMR			1
Total	**1**	**0**	**1**

	Steelhead Hatchery	Wild	Unknown
CLWRSF	1		
ELRH	5		
GRANDR	1		
IMNTRP	1		
LGRRBR		15	
LGRTAL	2		
MINP	1		
SNKTRP	2		
UMAR	3		
Total	**16**	**15**	

	Sockeye Hatchery	Wild	Unknown
NO DETECTIONS			

* Release site codes from the PIT Tag Information System specification document.

Appendix Table E1. Migration year 2001 juvenile spring/summer, fall, and unknown chinook PIT tags detected on the Little Memaloose Island gull colony, separated by hatchery, wild, and unknown rear types.

	Spring/summer chinook				Fall chinook		
Release site*	Hatchery (n)	Wild (n)	Unknown (n)	Release site	Hatchery (n)	Wild (n)	Unknown (n)
CARS	1			BCCAP	4		
CATHEP	5			CJRAP	1		
CHANDL		1		COLR	4	1	
CLARFP	4			MCNRRR			5
CLWR	17			PLAP	1		
COLR	55			UMAR	1		
EASTOP	5			**Total**	**11**	**1**	**5**
GRANDP	1						
GRANDR		1					
IMNAHW	5				Unknown chinook		
IMNTRP	2	2			Hatchery	Wild	Unknown
JACKCP	2				(n)	(n)	(n)
JDAR		1		IHR	1		
KNOXB	10			RIS	1		
LEAV	2			RRE	2		
LOOKGC	1			SALTRP	4	1	
RAPH	18			SNAKER	9		
RIS	27			**Total**	**17**	**1**	**0**
RRE	26						
WINT	2						
YAKIMR		4					
Total	**183**	**9**	**0**				

* Release site codes from the PIT Tag Information System specification document.

Appendix Table E2. Migration year 2001 juvenile steelhead, coho, and sockeye PIT tags detected on the Little Memaloose Island gull colony, separated by hatchery, wild, and unknow rear types.

	Steelhead				Coho		
Release site*	Hatchery (n)	Wild (n)	Unknown (n)	Release site	Hatchery (n)	Wild (n)	Unknown (n)
BCANF	1			PENP	1		
CLWR	1			WINT	1		
FISTRP		2		**Total**	**2**	**0**	**0**
GRANDR	1						
JDAR		1			Sockeye		
JOHTRP		1			Hatchery	Wild	Unknown
LGRRBR		1			(n)	(n)	(n)
LGRTAL	1	1		RIS		1	
MINP	1			RRE		1	
RIS	1			**Total**	**0**	**2**	**0**
RRE	1						
SALR	1						
SNKTRP	1						
WALH	1						
Total	**10**	**6**	**0**				

* Release site codes from the PIT Tag Information System specification document.

Appendix Table F1. Migration year 2001 juvenile spring/summer, fall, and unknown chinook PIT tags detected on the Little Miller Island gull colony, separated by hatchery, wild, and unknown rear types.

Release site	Spring/summer chinook			Release site	Fall chinook		
	Hatchery	Wild	Unknown		Hatchery	Wild	Unknown
CARS	3			BCCAP	18		
CATHEP	23			CJRAP	9		
CFCTRP		1		COLR	5		
CHANDL	5	2		LYFE	1		
CLARFP	33			MCNRRR			7
CLWR	70			PLAP	18		
COLR	344			PRDH	1		
EASTOP	21			RINH	1		
GRANDP	5			UMAR	4		
GRANDR	5	3		YAKIMR		1	
IMNAHR		1		**Total**	**57**	**1**	**7**
IMNAHW	30						
IMNTRP	18	18					
IMQP	3				Unknown chinook		
JACKCP	17				Hatchery	Wild	Unknown
JDAR		6		IHR	8		
JDARNF		1		LGRRBR		3	
JOHTRP		2		RIS	3		2
KNOXB	66			RRE	6		
KOOS	4			SALTRP	16	1	
LAKEC		5		SNAKER	80		
LEAV	21			SNKTRP	3		
LEMHIW		1		**Total**	**116**	**4**	**2**
LOLOC	1						
LOOKGC	1						
LOSTIP	9						
LSFTRP	1						
MINAMR		3					
NEWSOC	6						
PAHP	7						
PAHTRP		2					
RAPH	80						
RIS	150						
ROSAD	2						
RRE	145						
SALRSF	2						
SAWT	3						
SECESR		3					
TUCR		1					
UMAR		1					
WINT	13						
YAKIMR	5	3					
Total	**1,093**	**53**	**0**				

* Release site codes from the PIT Tag Information System specification document.

Appendix Table F2. Migration year 2001 juvenile steelhead PIT tags detected on the Little Miller Island gull colony, separated by hatchery, wild, and unknown rear types.

	Steelhead				Steelhead (cont.)		
Release site*	Hatchery (n)	Wild (n)	Unknown (n)	Release site	Hatchery (n)	Wild (n)	Unknown (n)
BARGAC		4		LSALR	5		
BCANF	5			LSHEEF	3		
BIRCHE		3		LYFE	6		
BIRCHW		2		MEACHC		7	
BONP	23			MINAMR		3	
CATHEC		1		MINP	78		
CFCTRP		5		PAHTRP	2		
CHAMBC		4		REDP	2		
CLEARC	9			RIS	45	15	
CLWR	44			RRE	35		
CLWRSF	5			SALEFT	5		
COTP	2			SALR	12		
CROOKP	3			SALTRP	16	5	
DAYP	11			SAWT	5		
FISHC		1		SFSTRP		1	
FISTRP		19		SLATEC		1	
GRANDR	30	5		SNKTRP	25	6	
HCD	5			SQUAWC	1		
HORSEC		1		STORMC		2	
IMNTRP	36	36		TUCR	9	5	
JDAR		8		UMAR	134	19	
JOHTRP		6		WALH	2		
LEMHIR	2			YANKWF	1		
LGRRBR		21		**Total**	**708**	**224**	**0**
LGRRRR	16	10					
LGRTAL	130	23					
LOLOC	1	6					
LOOKGC		3					
LOSTIR		2					

* Release site codes from the PIT Tag Information System specification document.

Appendix Table F3. Migration year 2001 juvenile coho and sockeye PIT tags detected on the Little Miller Island gull colony, separated by hatchery, wild, and unknown rear types.

	Coho				Sockeye		
Release site*	Hatchery (n)	Wild (n)	Unknown (n)	Release site	Hatchery (n)	Wild (n)	Unknown (n)
COLR			2	RIS	1	2	
LEAV	32			RRE		5	
NATCHR	48			**Total**	**1**	**7**	**0**
PENP	4						
UMAR			8				
WINT	13						
YAKIMR	9		6				
Total	**106**	**0**	**16**				

* Release site codes from the PIT Tag Information System specification document.

Appendix Table G1. Migration year 2001 juvenile spring/summer, fall, and unknown chinook PIT tags detected on the Three Mile Canyon Island gull colony, separated by hatchery, wild, and unknown rear types.

	Spring/summer chinook				Fall chinook		
Release site*	Hatchery (n)	Wild (n)	Unknown (n)	Release site	Hatchery (n)	Wild (n)	Unknown (n)
CATHEP	1			BCCAP	8		
CHANDL	2	1		CHANDL	3		
CLARFP	2			CJRAP	1		
CLWR	16			MCNRRR			2
COLR	41			PLAP	4		
CROOKP	1			THOP	3		
EASTOP	3			UMAR	4		
GRANDP	1			**Total**	**23**	**0**	**2**
GRANDR	1						
IMNAHW	7						
IMNTRP	4	2			Unknown chinook		
IMQP	1				Hatchery	Wild	Unknown
JACKCP	1				(n)	(n)	(n)
JDAR		1		LGRRBR		1	
KNOXB	15			RRE	1		
LAKEC		1		SALTRP	3	1	
LEAV	1			SNAKER	19		
LOOKGC	1			**Total**	**23**	**2**	**0**
LOSTIP	2						
PAHP	1						
RAPH	10						
RIS	14						
RRE	16						
TUCR	1						
UMAR		2					
WINT	3						
YAKIMR	1	3					
Total	**146**	**10**	**0**				

* Release site codes from the PIT Tag Information System specification document.

Appendix Table G2. Migration year 2001 juvenile steelhead, coho, and sockeye PIT tags detected on the Three Mile Canyon Island gull colony, separated by hatchery, wild, and unknown rear types.

	Steelhead				Coho		
Release site*	Hatchery (n)	Wild (n)	Unknown (n)	Release site	Hatchery (n)	Wild (n)	Unknown (n)
BCANF	1			CHANDL			4
BIRCHE		1		LEAV	12		
BONP	7			NATCHR	10		
BOULDC		1		PENP	5		
CFCTRP		1		UMAR			5
CHAMBC		2		WINT	2		
CLEARC	2			YAKIMR	1		2
CLWR	3			**Total**	**30**	**0**	**11**
CLWRSF	1						
DAYP	1						
FISHC		1			Sockeye		
FISTRP		6			Hatchery (n)	Wild (n)	Unknown (n)
GRANDR	3						
IMNTRP	5	7		RIS		2	
JACKSC	1			RRE		2	
JOHTRP		1		**Total**	**0**	**4**	**0**
LEMHIR	1						
LGRRBR		3					
LGRRRR	3						
LGRTAL	14	2					
LGRTAL	14	2					
LOLOC	1						
LOOKGC		3					
LSALR	1						
LSFTRP		1					
LYFE	2						
MINP	15						
PAHTRP	1	1					
RIS	7						
RRE	3						
SALEFT	1						
SALR	3						
SALTRP	4	1					
SNKTRP	3	1					
STORMC		1					
TUCR	2						
UMAR	27	1					
WALH	1						
WBIRDC		2					
Total	**113**	**36**	**0**				

* Release site codes from the PIT Tag Information System specification document.

Appendix Table H1. Migration year 2001 juvenile spring/summer, fall, unknown chinook, steelhead, coho, and sockeye PIT tags detected from the Three Mile Canyon Island tern colony, separated by hatchery, wild, and unknown rear types.

Spring/summer chinook				Steelhead			
Release site*	Hatchery (n)	Wild (n)	Unknown (n)	Release Site*	Hatchery (n)	Wild (n)	Unknown (n)
COLR	1			CLWR	1		
IMQP	1			MINP	1		
RRE	1	0	0	TUCR	1		
Total	**3**	**0**	**0**	UMAR	1	1	0
				Total	**4**	**1**	**0**

Fall chinook				Coho		
Hatchery (n)	Wild (n)	Unknown (n)		Hatchery (n)	Wild (n)	Unknown (n)
NO DETECTIONS			NATCHR	1		
			YAKIMR	2		
			Total	**3**	**0**	**0**

Unknown chinook				Sockeye		
Hatchery (n)	Wild (n)	Unknown (n)		Hatchery (n)	Wild (n)	Unknown (n)
NO DETECTIONS				NO DETECTIONS		

* Release site codes from the PIT Tag Information System specification document.

Appendix Table I1. Migration year 2001 juvenile spring/summer chinook PIT tags detected on the Crescent Island tern colony, separated by hatchery, wild, and unknown rear types.

Release site*	Spring/summer chinook			Release site	Spring/summer chinook (cont.)		
	Hatchery (n)	Wild (n)	Unknown (n)		Hatchery (n)	Wild (n)	Unknown (n)
BEARVC		1		LOLOC	20	7	
CATHEC	2	9		LOOKGC	18		
CATHEP	192			LOSTIP	123		
CFCTRP		3		LOSTIR	4	18	
CHANDL	10	13		MEADOC		7	
CLARFP	103			MINAMR		20	
CLWR	682			NEWSOC	21		
COLR	762			PAHP	35		
COLTKC		2		PAHTRP		21	
CROOKP	9			POWP	8		
CROTRP	1			RAPH	549		
EASTOP	78			REDP	1		
FISTRP		4		REDTRP		3	
GRANDP	11			RIS	368		
GRANDR	36	25		ROSAD	13	7	
IMNAHR		8		RRE	396		
IMNAHW	285	24		SALRSF	14	6	
IMNTRP	77	228		SAWT	9		
IMQP	10			SAWTRP		11	
JACKCP	90			SECESR		27	
JDAR		1		SFSTRP	1	5	
JOHNSC		2		TUCR	8	1	
JOHTRP		40		UMAR	4		
KNOXB	732			VALEYC		8	
KOOS	12			WELH	15		
LAKEC		23		WINT	165		
LEAV	173			YAKIMR	26	32	
LEMHIR		4		**Total**	**5,063**	**578**	**0**
LEMHIW		18					

* Release site codes from the PIT Tag Information System specification document.

Appendix Table I2. Migration year 2001 juvenile fall and unknown chinook PIT tags detected on the Crescent Island tern colony, separated by hatchery, wild, and unknown rear types.

	Fall chinook				Unknown chinook		
Release site*	Hatchery (n)	Wild (n)	Unknown (n)	Release site	Hatchery (n)	Wild (n)	Unknown (n)
BCANF	1			IHR	40		
BCCAP	167			LGRBPS	4		
CHANDL	18	1		LGROFL	4		
CJRAP	58			LGRRBR		8	
COLR	78	27		RIS	26		31
LYFE	17			RRE	79		1
MCNRRR			5	SALTRP	118	39	
PLAP	150			SNAKER	561		
PRDH	8			SNKTRP	13		
RINH	4			**Total**	**845**	**47**	**32**
SNAKER	20						
THOP	1						
TUCR		1					
UMAR	11						
YAKIMR	1	1					
Total	**534**	**30**	**5**				

* Release site codes from the PIT Tag Information System specification document.

Appendix Table I3. Migration year 2001 juvenile steelhead PIT tags detected on the Crescent Island tern colony, separated by hatchery, wild, and unknown rear types.

	Steelhead				Steelhead (cont.)		
Release site*	Hatchery (n)	Wild (n)	Unknown (n)	Release site	Hatchery (n)	Wild (n)	Unknown (n)
AMERR	3			LOSTIR		18	
BARGAC		14		LSALR	48		
BCANF	71			LSFTRP		7	
BONP	1			LSHEEF	39		
BOULDC		16		LYFE	30		
BRUSHC		27		MARSHC		3	
CATCSF		1		MEADOC		1	
CATHEC		19		MINAMR	1	26	
CFCTRP		17		MINP	6		
CHAMBC		40		NEWSOC	6	15	
CLEARC	77	6		OHARAC		5	
CLWR	297			PAHTRP	14	9	
CLWRSF	87			REDP	17		
COLTKC		12		REDTRP		2	
COTNWC	2			RIS	166	95	
COTP	20			RRE	81		
CROOKP	10			SALEFT	24		
DAYP	9			SALR	89		
DEADMC		1		SALTRP	189	36	
FISHC		23		SAWT	21		
FISTRP		332		SAWTRP		4	
GEDCWF		3		SECESR		1	
GEDNEC		7		SFSTRP		1	
GRANDR	142	51		SLATEC		6	
HCD	11			SNKTRP	175	74	
HERDC		1		SQUAWC	16		
HORSEC		7		SQUAWP	30		
IMNTRP	223	244		STORMC		6	
JACKSC	1			TUCR	84	40	
JOHTRP		60		UMAR	14		
LAKEC		1		VALEYC		1	
LEMHIR	19			WALH	48		
LGRRBR		21		WBIRDC		12	
LGRRRR	114	22		WHITSC		5	
LGRTAL	963	222		YANKWF	16		
LOLOC	6	59		**Total**	**3,170**	**1,620**	**0**
LOOKGC		47					

* Release site codes from the PIT Tag Information System specification document.

Appendix Table I4. Migration year 2001 juvenile coho and sockeye PIT tags detected on the Crescent Island tern colony, separated by hatchery, wild, and unknown rear types.

	Coho				Sockeye		
Release site*	Hatchery (n)	Wild (n)	Unknown (n)	Release site	Hatchery (n)	Wild (n)	Unknown (n)
CHANDL			16	ALTULC	1		
COLR			8	REDFLC	5		
LAPC	4			RIS		7	
LEAV	651			RLCTRP	4		
NATCHR	158			RRE		31	
PENP	2			**Total**	**10**	**38**	**0**
POTR	1						
RRE	19						
UMAR			2				
WINT	357						
YAKIMR	47		19				
Total	**1,239**	**0**	**45**				

* Release site codes from the PIT Tag Information System specification document.

Appendix Table J1. Migration year 2001 juvenile spring/summer, fall, and unknown chinook PIT tags detected on the Crescent Island gull colony, separated by hatchery, wild, and unknown rear types.

	Spring/summer chinook				Fall chinook		
Release site*	Hatchery (n)	Wild (n)	Unknown (n)	Release site	Hatchery (n)	Wild (n)	Unknown (n)
BEARVC		1		BCCAP	16		
CARS	1			CHANDL	3	1	
CATHEC	1			CJRAP	5		
CATHEP	6			COLR	4	1	
CLARFP	3			LYFE	1		
CLWR	35			MCNRRR			1
COLR	41			PLAP	10		
EASTOP	7			SNAKER	2		
GRANDP	3			THOP	2		
GRANDR	4	1		UMAR	4		
IMNAHW	17	2		**Total**	**47**	**2**	**1**
IMNTRP	4	12					
IMQP	1						
JACKCP	6				Unknown chinook		
JOHTRP		5		Release site	Hatchery (n)	Wild (n)	Unknown (n)
KNOXB	45						
LEAV	5			IHR	2		
LEMHIW		3		LGROFL	1		
LOOKGC	1			LGRRBR		4	
LOSTIP	7			RIS	1		
LOSTIR		1		RRE	2		
MINAMR		1		SALTRP	6	3	
NEWSOC	1			SNAKER	23		
PAHP	3			SNKTRP	1		
PAHTRP		1		UMAR		2	
POWP	1			**Total**	**36**	**9**	**0**
RAPH	35						
RIS	19						
ROSAD	1						
RRE	28						
SAWT	1						
SECESR		1					
SFSTRP		1					
UMAR		1					
WELH	1						
WINT	5						
YAKIMR	1	2					
Total	**283**	**32**	**0**				

* Release site codes from the PIT Tag Information System specification document.

Appendix Table J2. Migration year 2001 juvenile steelhead PIT tags detected on the Crescent Island gull colony, separated by hatchery, wild, and unknown rear types.

	Steelhead				Steelhead (cont.)		
Release site*	Hatchery (n)	Wild (n)	Unknown (n)	Release site	Hatchery (n)	Wild (n)	Unknown (n)
AMERR	4			LOSTIR		3	
BCANF	14			LSALR	12		
BONP	1			LSFTRP		1	
BOULDC		1		LSHEEF	9		
BRUSHC		1		LYFE	2		
CATHEC		1		MARSHC		1	
CFCTRP		3		MEACHC		2	
CHAMBC		4		MINAMR		2	
CLEARC	9	1		MINP	4		
CLWR	52			NEWSOC	3		
CLWRSF	20			PAHTRP	2		
COLTKC		2		REDP	1		
COTNWC	1			REDTRP		1	
COTP	2			RIS	40	17	
CROOKP	5			RRE	19		
FISHC		3		SALEFT	2		
FISTRP		45		SALR	25		
GEDNEC		3		SALTRP	46	5	
GRANDR	33	7		SAWT	4		
HCD	4			SFSTRP		1	
HORSEC		2		SNKTRP	38	9	
IMNTRP	66	25		SQUAWC	6		
JACKSC	1			SQUAWP	4		
JOHTRP		12		TUCR	15	2	
LGRRBR		4		UMAR	8	1	
LGRRRR	48	5		WALH	11		
LGRTAL	234	38		WBIRDC		3	
LOLOC	2	4		YANKWF	3		
LOOKGC		5		**Total**	**750**	**214**	**0**

* Release site codes from the PIT Tag Information System specification document.

Appendix Table J3. Migration year 2001 juvenile coho and sockeye PIT tags detected on the Crescent Island gull colony, separated by hatchery, wild, and unknown rear types.

	Coho				Sockeye		
Release Site*	Hatchery (n)	Wild (n)	Unknown (n)	Release Site	Hatchery (n)	Wild (n)	Unknown (n)
COLR			14	REDFLC	1		
LEAV	14			RRE		4	
NATCHR	7			**Total**	**1**	**4**	**0**
WINT	4						
YAKIMR	1						
Total	**26**	**0**	**1**				

* Release site codes from the PIT Tag Information System specification document.

Appendix Table K1. Migration year 2001 juvenile spring/summer, fall, and unknown chinook PIT tags detected on the Badger Island pelican colony, separated by hatchery, wild, and unknown rear types.

	Spring/summer chinook				Fall chinook		
Release site*	Hatchery (n)	Wild (n)	Unknown (n)	Release site	Hatchery (n)	Wild (n)	Unknown (n)
CLARFP	1			CHANDL			1
CLWR	4			COLR	3		
COLR	18			PLAP	1		
EASTOP	5			YAKIMR	1		1
IMNAHW	4			**Total**	**5**	**0**	**2**
IMNTRP	1	1					
IMQP	1						
JACKCP	1						
JOHTRP		2			Unknown chinook		
KNOXB	9				Hatchery (n)	Wild (n)	Unknown (n)
LOLOC		1					
LOOKGC	1			SNAKER	2		
LOSTIP	2			**Total**	**2**	**0**	**0**
LOSTIR		1					
RAPH	2						
RIS	6						
RRE	5						
Total	**60**	**5**	**0**				

* Release site codes from the PIT Tag Information System specification document.

Appendix Table K2. Migration year 2001 juvenile steelhead, coho, and sockeye PIT tags detected on the Badger Island pelican colony, separated by hatchery, wild, and unknown rear types.

	Steelhead				Coho		
Release site*	Hatchery (n)	Wild (n)	Unknown (n)	Release site	Hatchery (n)	Wild (n)	Unknown (n)
BCANF	2			CHANDL			1
CATHEC		1		LEAV	8		
CHAMBC		2		NATCHR	3		
CLWR	5			PENP	2		
CROOKP	1			UMAR			1
FISTRP		3		WINT	1		
GRANDR	4	1		YAKIMR	3		1
HCD	1			**Total**	**17**	**0**	**3**
HORSEC		1					
IMNTRP	9	1			Sockeye		
JOHTRP		1			Hatchery (n)	Wild (n)	Unknown (n)
LEMHIR	1						
LGRRRR	3				NO DETECIONS		
LGRTAL	24	4					
LSALR	2						
LSHEEF	2						
LYFE	1						
NEWSOC	2						
PAHTRP	1	1					
RIS	6	2					
SALR	1						
SALTRP	6						
SAWT	1						
SNKTRP	5	1					
SQUAWC	1						
TUCR	5						
WALH	1						
Total	**84**	**18**	**0**				

* Release site codes from the PIT Tag Information System specification document.

Appendix Table L1. Migration year 2001 juvenile spring/summer chinook PIT tags detected on the Foundation Island cormorant colony, separated by hatchery, wild, and unknown rear types.

	Spring/summer chinook				Spring/summer chinook (cont.)		
Release site*	Hatchery (n)	Wild (n)	Unknown (n)	Release site	Hatchery (n)	Wild (n)	Unknown (n)
CATHEC		2		MINAMR		2	
CATHEP	22			NEWSOC	1		
CHANDL	8	4		PAHP	5		
CLARFP	21			PAHTRP		2	
CLWR	95			RAPH	66		
COLR	89			REDTRP		1	
EASTOP	20			RIS	41		
GRANDR	2	1		ROSAD		1	
IMNAHR		1		RRE	46		
IMNAHW	31			SALRSF	2		
IMNTRP	9	30		SAWT	1		
IMQP	3			SAWTRP		1	
JACKCP	23			SECESR		1	
JOHNSC		1		STOLP	1		
JOHTRP		4		TUCR	1		
KNOXB	104			UMAR	1		
KOOS	3			WELH	2		
LAKEC		6		WINT	6		
LEAV	3			YAKIMR	6	11	
LOLOC	3	1		**Total**	**637**	**71**	**0**
LOOKGC	3						
LOSTIP	17						
LOSTIR	2	1					
MEADOC		1					

* Release site codes from the PIT Tag Information System specification document.

Appendix Table L2. Migration year 2001 juvenile fall and unknown chinook PIT tags detected on the Foundation Island cormorant colony, separated by hatchery, wild, and unknown rear types.

	Fall chinook				Unknown chinook		
Release site*	Hatchery (n)	Wild (n)	Unknown (n)	Release site	Hatchery (n)	Wild (n)	Unknown (n)
BCCAP	29			IHR	1		
CHANDL	35	1	1	LGRRBR		7	
CJRAP	13			RIS	1		2
COLR	29	63		RRE	5		
LYFE	6			SALTRP	20	4	
PLAP	44			SNAKER	69		
PRDH	3			SNKTRP	1		
RINH	7			**Total**	**97**	**11**	**2**
SNAKER	5						
UMAR	12						
YAKIMR	1		1				
Total	**184**	**64**	**2**				

* Release site codes from the PIT Tag Information System specification document.

Appendix Table L3. Migration year 2001 juvenile steelhead PIT tags detected on the Foundation Island cormorant colony, separated by hatchery, wild, and unknown rear types.

	Steelhead				Steelhead (cont.)		
Release site*	Hatchery (n)	Wild (n)	Unknown (n)	Release site	Hatchery (n)	Wild (n)	Unknown (n)
AMERR	2			LSALR	23		
BARGAC		1		LSFTRP		2	
BCANF	5			LSHEEF	6		
BIRCHE		1		LYFE	3		
BONP	2			MEACHC		1	
BOULDC		2		MINAMR		5	
BRUSHC		3		MINP	4		
CATHEC		2		NEWSOC	1	3	
CFCTRP		3		OHARAC		1	
CHAMBC		7		PAHTRP	7	4	
CLEARC	15			REDP	5		
CLWR	64			RIS	6		
CLWRSF	17			RRE	5		
COLTKC		3		SALEFT	3		
COTNWC	2			SALR	29		
COTP	4			SALTRP	48	5	
CROOKP	6			SAWT	9		
DAYP	20			SECESR		2	
FISHC		1		SLATEC		1	
FISTRP		35		SNKTRP	59	20	
GEDNEC		1		SQUAWC	2		
GRANDR	36	12		SQUAWP	2		
HCD	2			STORMC		1	
HORSEC		6		TUCR	13	2	
IMNTRP	46	53		UMAR	16	2	
JOHTRP		20		WALH	9		
LEMHIR	1			WBIRDC		4	
LGRRBR		1		YANKWF	3		
LGRRR	48	7		**Total**	**806**	**293**	**0**
LGRTAL	277	58					
LOLOC	6	8					
LOOKGC		11					
LOSTIR		5					

* Release site codes from the PIT Tag Information System specification document.

Appendix Table L4. Migration year 2001 juvenile coho and sockeye PIT tags detected on the Foundation Island cormorant colony, separated by hatchery, wild, and unknown rear types.

	Coho				Sockeye		
Release site*	Hatchery (n)	Wild (n)	Unknown (n)	Release site	Hatchery (n)	Wild (n)	Unknown (n)
CHANDL			7	REDFLC	3		
COLR			2	RIS	1	1	
LAPC	1			RLCTRP	3		
LEAV	24			RRE		9	
NATCHR	11			**Total**	**7**	**10**	**0**
PENP	2						
UMAR			3				
WINT	9						
YAKIMR	9		3				
Total	**56**	**0**	**15**				

* Release site codes from the PIT Tag Information System specification document.

Appendix Table M1. Migration year 2001 juvenile spring/summer, fall, and unknown chinook PIT tags detected on the Richland Island gull colony, separated by hatchery, wild, and unknown rear types.

	Spring/summer chinook				Fall chinook (cont.)		
Release site*	Hatchery (n)	Wild (n)	Unknown (n)	Release site	Hatchery (n)	Wild (n)	Unknown (n)
CATHEC	1			BCCAP	8		
CATHEP	4			CHANDL	7		4
CHANDL	11	4		CJRAP	1		
CLARFP	62			COLR	10	2	
CLWR	14			MCNRRR			4
COLR	68			PLAP	12		
CROOKP	1			RINH	4		
EASTOP	66			SNAKER	3		
IMNAHW	4			YAKIMR	1	1	6
IMNTRP	1	4		Total	46	3	14
JACKCP	71						
KNOXB	16						
LEAV	7				Unknown chinook		
LOSTIP	5				Hatchery	Wild	Unknown
LOSTIR		1			(n)	(n)	(n)
NEWSOC	1			RIS	3		
PAHP	4			RRE	4		1
RAPH	12			SALTRP	4	2	
RIS	74			SNAKER	3		
ROSAD	1			SNKTRP	1		
RRE	85			Total	15	2	1
WELH	2						
WINT	5						
YAKIMR	10	4					
Total	525	13	0				

* Release site codes from the PIT Tag Information System specification document.

Appendix Table M2. Migration year 2001 juvenile steelhead PIT tags detected on the Richland Island gull colony, separated by hatchery, wild, and unknown rear types.

	Steelhead				Steelhead (cont.)		
Release site*	Hatchery (n)	Wild (n)	Unknown (n)	Release site	Hatchery (n)	Wild (n)	Unknown (n)
AMERR	2			LOSTIR		2	
BARGAC		1		LSALR	8		
BCANF	7			LSHEEF	3		
BOULDC		1		LYFE	4		
CATHEC		1		MARSHC		1	
CFCTRP		1		MINAMR		3	
CHAMBC		3		NEWSOC	3	1	
CLEARC	9	1		PAHTRP	4		
CLWR	32			REDP	3		
CLWRSF	7			RIS	41	11	
COTNWC	1			RRE	20		
COTP	3			SALEFT	1		
CROOKP	3			SALR	10		
FISHC		1		SALTRP	24		
FISTRP		17		SAWT	8		
GRANDR	14	4		SLATEC		1	
HCD	1			SNKTRP	19	4	
HORSEC		1		SQUAWC	2		
IMNTRP	29	10		SQUAWP	6		
JOHTRP		7		TUCR	9	2	
LEMHIR	3			WALH	9		
LGRRRR	30	2		WBIRDC		2	
LGRTAL	160	11		YANKWF	1		
LOLOC	1			**Total**	**477**	**94**	**0**
LOOKGC		6					

* Release site codes from the PIT Tag Information System specification document.

Appendix Table M3. Migration year 2001 juvenile coho and sockeye PIT tags detected on the Richland Island gull colony, separated by hatchery, wild, and unknown rear types.

	Coho				Sockeye		
Release site*	Hatchery (n)	Wild (n)	Unknown (n)	Release site	Hatchery (n)	Wild (n)	Unknown (n)
CHANDL			32	REDFLC	1		
LEAV	17			RIS		1	
NATCHR	80			RLCTRP	1		
POTR	1			RRE		5	
WINT	5			**Total**	**2**	**6**	**0**
YAKIMR	36		33				
Total	**139**	**0**	**65**				

* Release site codes from the PIT Tag Information System specification document.

Appendix Table N1. Migration year 2001 juvenile spring/summer, fall, and unknown chinook PIT tags detected on the Island 18 gull colony, separated by hatchery, wild, and unknown rear types.

	Spring/summer chinook				Fall chinook		
Release site*	Hatchery (n)	Wild (n)	Unknown (n)	Release site	Hatchery (n)	Wild (n)	Unknown (n)
CARS	1			BCCAP	3		
CHANDL	1	1		CHANDL	5		1
CLARFP	42			CJRAP	1		
COLR	43			COLR	13	3	
EASTOP	37			PLAP	1		
IMNAHW	2			PRDH	1		
IMNTRP	1	4		RINH	9		
IMQP	2			YAKIMR	2	1	1
JACKCP	46			**Total**	**35**	**4**	**2**
KNOXB	6						
LEAV	5				Unknown chinook		
LEMHIW		1			Hatchery (n)	Wild (n)	Unknown (n)
LOSTIP	1						
RAPH	2			RIS	3		
RIS	47			RRE	6	1	
RRE	51			**Total**	**9**	**1**	**0**
SFSTRP		1					
WINT	3						
YAKIMR	10						
Total	**300**	**7**	**0**				

* Release site codes from the PIT Tag Information System specification document.

Appendix Table N2. Migration year 2001 juvenile steelhead, coho, and sockeye PIT tags detected on the Island 18 gull colony, separated by hatchery, wild, and unknown rear types.

	Steelhead				Coho		
Release site*	Hatchery (n)	Wild (n)	Unknown (n)	Release site	Hatchery (n)	Wild (n)	Unknown (n)
AMERR	1			CHANDL			11
BCANF	1			LEAV	16		
BONP	1			NATCHR	59		
CFCTRP		2		RRE	1		
CHAMBC		2		WINT	9		
CLWR	11			YAKIMR	23		13
CLWRSF	2			**Total**	**108**	**0**	**24**
CROOKP	1						
FISHC		1					
FISTRP		5			Sockeye		
GRANDR	3	2			Hatchery (n)	Wild (n)	Unknown (n)
HCD	1						
HORSEC		1		RIS		1	
IMNTRP	6	5		RRE		6	
JOHTRP		2		**Total**	**0**	**7**	**0**
LGRRRR	4						
LGRTAL	45	5					
LOOKGC		1					
LOSTIR		1					
LSALR	2						
NEWSOC	1						
REDP	2						
RIS	21	4					
RRE	7						
SALR	4						
SALTRP	2	1					
SAWT	1						
SFSTRP		1					
SNKTRP	9	2					
SQUAWC	2						
TUCR	3						
WALH	1						
WBIRDC		1					
Total	**131**	**36**	**0**				

* Release site codes from the PIT Tag Information System specification document.

Appendix Table O1. Migration year 2001 juvenile spring/summer, fall, unknown chinook, coho, steelhead, and sockeye PIT tags detected on the Solstice Island tern colony, separated by hatchery, wild, and unknown rear types.

	Spring/summer chinook				Steelhead		
Release site*	Hatchery (n)	Wild (n)	Unknown (n)	Release site	Hatchery (n)	Wild (n)	Unknown (n)
CATHEP	1			CLWR	2		
CHANDL	1			GRANDR		1	
COLR	394			JOHTRP		1	
KNOXB	1			LGRTAL	2		
LEAV	44			LSALR	1		
RIS	400			RIS	119	39	
RRE	376			RRE	58		
WELH	5			SALTRP	3		
WINT	34			SNKTRP	1		
YAKIMR	1			UMAR	1		
Total	**1,257**	**0**	**0**	**Total**	**187**	**41**	**0**

	Fall chinook				Coho		
	Hatchery (n)	Wild (n)	Unknown (n)		Hatchery (n)	Wild (n)	Unknown (n)
BCCAP	1			LAPC	1		
COLR	56			LEAV	76		
PLAP	1			NATCHR	1		
PRDH	6			RIS			1
Total	**64**	**0**	**0**	RRE	8		
				WINT	50		
				Total	**86**	**0**	**1**

	Unknown chinook				Sockeye		
	Hatchery (n)	Wild (n)	Unknown (n)		Hatchery (n)	Wild (n)	Unknown (n)
RIS	6		6				
RRE	28			RRE	0	6	
Total	**34**	**0**	**6**	**Total**	**0**	**6**	**0**

* Release site codes from the PIT Tag Information System specification document.