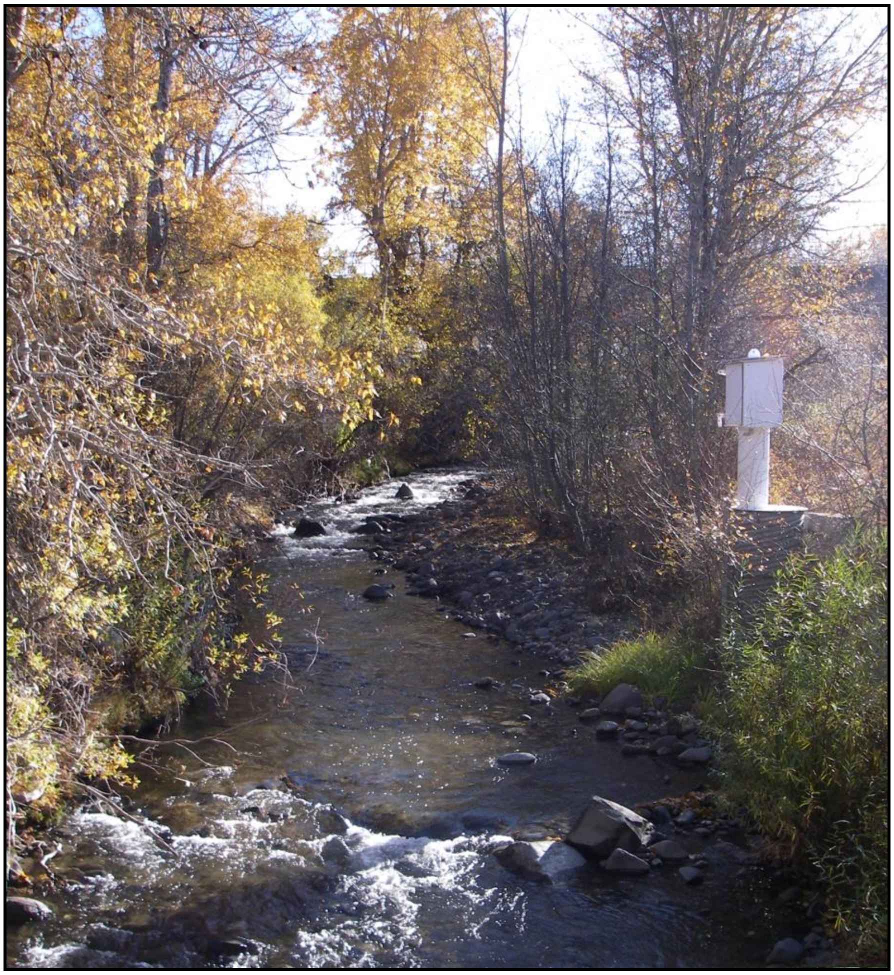
U.S. Fish and Wildlife Service

Steelhead Return to Taneum Creek Following Habitat Restoration



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On the cover: *Taneum Creek at the "TAN" PIT-tag interrogation site.*

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Abstract—Taneum Creek, a tributary to the Yakima River in Kittitas County, Washington, supported runs of salmon and steelhead trout until the early 1900s when fish access to the stream was blocked, resulting in the loss of the fishery. In the 1980s, the creek was identified as a high priority stream for restoration of fish runs. Restoration actions included screening irrigation diversions, constructing fishways, removing dams, and restoring instream flow and habitat conditions. PIT-tag interrogation sites were constructed and installed at key locations on the creek in 2010 and 2011 with the objective of monitoring fish returns to the creek. Adult steelhead have naturally recolonized Taneum Creek, with counts of PIT-tagged adults ranging from 29 to 66 during the 2010-2014 monitoring period, most of which spawned in the creek. PIT-tag arrays also detected movements of rainbow trout, cutthroat trout, coho, and Chinook salmon in the creek on a year-round basis. Data collected from PIT-tag sites demonstrated that the newly constructed fish passage structures allowed fish to migrate freely up and down the creek. A number of tributary streams remain disconnected from the Yakima River, presenting opportunities to further steelhead recovery. Continued monitoring is recommended to evaluate fishery restoration activities for long-term viability and contribution to recovery of ESA-listed steelhead.

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Introduction

Taneum Creek, located on the east side of the Cascades Mountains in Kittitas County, Washington flows in to the Yakima River approximately 10 miles northwest of Ellensburg (Figure 1). The creek supported runs of coho salmon (*Oncorhynchus kisutch*) and steelhead trout (*O. mykiss*) until the early 1900's. By that time anadromous fish runs were extirpated from all but the lower mile of the watershed, primarily due to the construction of irrigation diversion dams which blocked migrating fish and completely dewatered portions of the creek (McIntosh et al. 1995). Relatively healthy populations of rainbow (*O. mykiss*) and cutthroat trout (*O. clarki*) inhabited the upper forested areas of the watershed, indicating Taneum Creek maintained productive aquatic habitat (Johnston 1979, Pearsons et al. 1998). With a basin area of 82.9 mi^2 (214.7 km^2), approximately 30 miles (48 km) of contiguous stream channels, and a mean annual flow of 66 cfs (1.9 cms), Taneum Creek was considered a good candidate for restoring anadromous fish runs. Much of the watershed had good habitat conditions, and in contrast to other streams in the Kittitas Valley, there were few water diversions (Toth 1995, Jones and Stokes Associates 1991).

Restoration efforts began in the late 1980s when fishways (a.k.a. fish ladders) and screens were constructed on the Taneum Creek diversion dams (Bruton Ditch, Taneum Canal Company, and Knudson-Mann Ditch) by the U.S. Department of the Interior, Bureau of Reclamation (Reclamation) and the U.S. Department of Energy, Bonneville Power Administration (BPA). In 1994 the Title XII legislation, Public Law 103-434, of the Yakima River Basin Water Enhancement Project (YRBWEP) was passed specifically identifying Taneum Creek as a high priority for tributary enhancement projects. In 1999, steelhead trout in the Yakima Basin were listed as threatened under the Endangered Species Act (ESA), emphasizing the need for fish

Figure 1. Taneum Creek is located in the upper Yakima River basin in central Washington.

recovery. Funding sources were identified, and many local citizens and agencies participated in Taneum Creek enhancement projects, including representatives of Taneum Canal Company (TCC), other water users, Kittitas Reclamation District (KRD), Yakama Nation (YN) Fisheries, National Marine Fisheries Service (NMFS), U.S. Fish and Wildlife Service (USFWS), Washington Water Trust, Washington Departments of Ecology (WDOE) and Fish and Wildlife (WDFW), Kittitas County Conservation District, Kittitas Conservation Trust, Washington Conservation Corps, and local landowners. With so many people involved, restoring salmon and steelhead runs to Taneum Creek had become a social priority (Temple et al. 2007, Conley et al. 2008).

Over the course of two decades many projects were implemented by the entities managing Taneum Creek resources. TCC winter stock water (conveyance water) rights were sold and placed in trust. Bruton Diversion Dam was demolished and a roughened channel was constructed at the former dam site, the water rights were placed in trust for instream flow uses, and the water users were served by the KRD via a water exchange. The TCC dam and fishway was rebuilt to improve fish passage; the Heart K Ranch was purchased by Reclamation-YRBWEP for habitat restoration and its water rights were reallocated to the trust program to improve instream flows. YN Fisheries and WDFW collaborated on implementing an innovative, large-scale stream channel and floodplain habitat restoration effort and initiated a coho salmon reintroduction study. Most projects were underway or completed by 2011. Considering that human activities had made Taneum Creek inhospitable for salmon and steelhead for most of the 20th Century, these actions constituted substantial efforts towards watershed and fishery restoration (Figure 2).

How did Taneum Creek fishery resources respond to the restoration actions? In order to answer this question, the USFWS, in cooperation with WDFW and YN Fisheries, started monitoring fish returns to Taneum Creek using instream PIT-tag monitoring arrays. PIT (passive integrated transponder) tags are electronic tags about the size of a grain of rice which are implanted in fish and used throughout the Columbia River Basin to evaluate fish movements, survival, and other biological characteristics. Each PIT-tag has a unique code using radio frequency identification (RFID) technology. When tagged fish pass RFID equipment, the tag code is read (interrogated) and stored along with the time and date of passage. PIT-tag interrogation sites are installed at dams and in streams throughout the Columbia River Basin. Interrogation sites can be very efficient, capable of detecting greater than 90 percent of tagged fish present; directional movements of fish can be determined by using multiple antennas (Zydelewski et al. 2006, Connolly et al. 2007). PIT-tags used in fish in the Columbia River Basin are coordinated through a central database operated by the Pacific States Marine Fisheries Commission known as the PIT-tag Information System (PTAGIS). The PTAGIS database makes all data publicly available on the internet at www.ptagis.org. This report describes the results of monitoring PIT-tagged fish in Taneum Creek from 2010 through 2014, focusing on adult steelhead returns.

Lastly, a comment on nomenclature: rainbow and steelhead trout are two forms of the same species. They have complex life-history pathways in contrast to Pacific salmon, which are mostly obligated to go to the ocean, return, and die after spawning. Unlike salmon, rainbow or steelhead trout can spawn multiple times. Individual fish may remain in their natal stream as resident trout, become migratory trout within the larger freshwater ecosystem, or they can migrate to the ocean and return to their natal stream as anadromous steelhead. For the purposes of this report, rainbow trout were freshwater residents or juvenile fish that could not be distinguished; steelhead trout were observed migrating to or from the Pacific Ocean.


(A)


(B)


(C)

Figure 2. Habitat improvements to Taneum Creek: (A) Bruton Diversion Dam prior to demolition; (B) Roughened channel replacing Bruton Dam; (C) Pipeline to provide pressurized irrigation water to the Bruton Ditch water users in exchange for retiring the diversion.

Objectives

The objectives of this report are to (1) describe detections of PIT-tagged fish through the reconstructed TCC diversion dam, and (2) review and discuss some highlights of the data collected at an instream PIT-tag array near the mouth of Taneum Creek (TAN), particularly with regard to adult steelhead (Figure 3).

Methods

Objective 1, materials and methods. Trout and salmon inhabiting Taneum Creek were PIT-tagged by WDFW crews as part of the Yakima-Klickitat Fisheries Project (YKFP) at multiple locations throughout the watershed. In addition, returning adult steelhead were trapped and tagged by YN Fisheries staff at Roza and Prosser dams on the Yakima River. Migrating adult and juvenile steelhead could also be captured and tagged at other locations in the Columbia Basin. In order to take advantage of these efforts USFWS personnel installed instream PIT-tag interrogation sites in Taneum Creek to monitor fish movements in and out of the creek and past the newly reconstructed TCC diversion dam.

Antennas to detect PIT-tags were constructed out of wire and PVC pipe, connected to PIT-tag interrogation equipment manufactured by the Allflex Corporation, and installed on the TCC dam and fishway. The site started operation on February 29, 2012. Interrogation equipment was

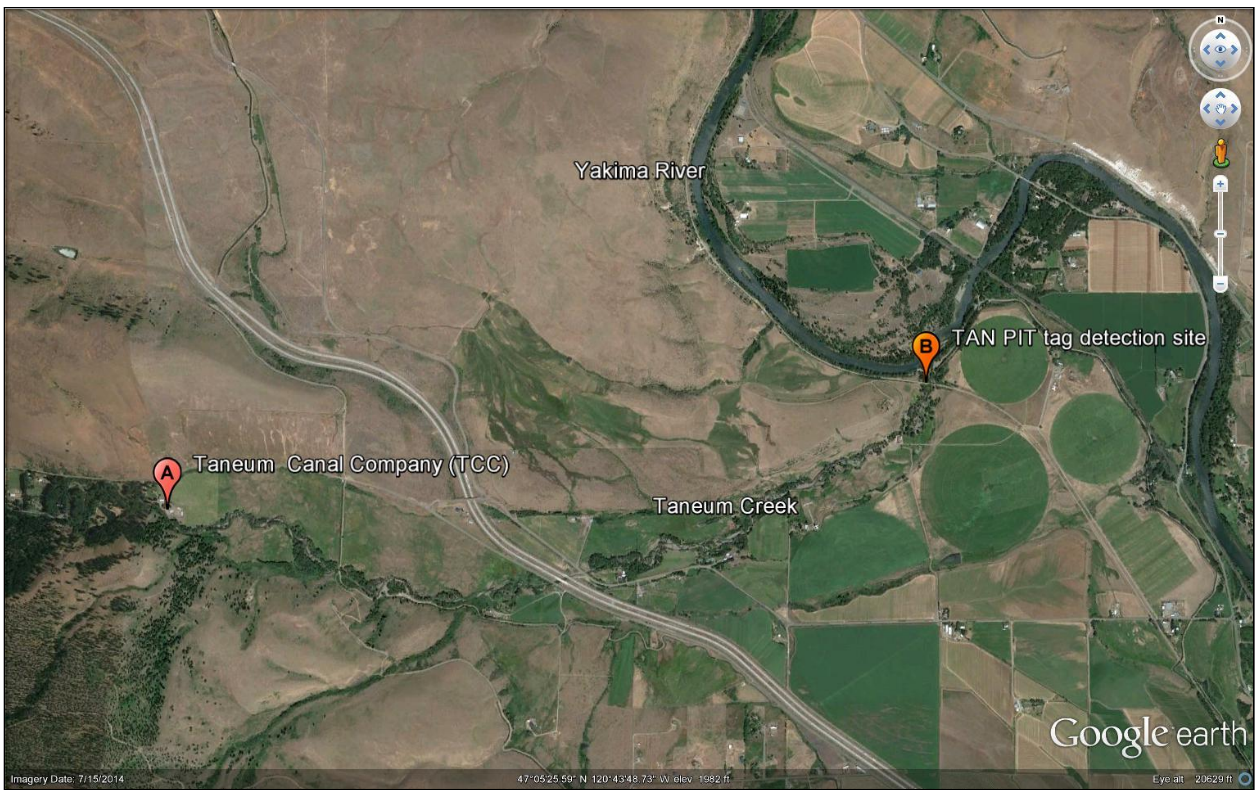

Figure 3. Locations of TAN and TCC PIT-tag detection sites in Taneum Creek.

powered by two solar panels charging two 12-volt batteries. Antenna TCC1 was installed near the upstream end of the roughened channel fishway and TCC2 was installed in the center-left bay of the diversion dam. Both antennas were set up in a "pass through" configuration (Figure 4) to maximize detection probabilities (Zydelewski et al. 2006).

Two antennas allowed fish movements through the site to be recorded during the full range of operations of the TCC dam (Figure 4). The TCC dam was operated in one of two configurations depending upon the season and the amount of streamflow. During the spring, head gates were opened, diverting water into the canal, and the dam bays were left open to pass flood events. Fish could swim upstream or downstream via the roughened channel fishway (TCC1) or through the dam bays (TCC2). Once the spring freshet diminished, stop logs were placed in the dam to divert water. Migrating fish then had to travel through the roughened channel fishway or down the canal.

Objective 2, materials and methods. The main PIT-tag interrogation site on Taneum Creek, TAN, was installed near the mouth of the creek about 150 feet upstream of the confluence with the Yakima River (Figure 3). TAN started operating on February 18, 2010, with three 20-foot-long by 3-foot-wide antennas enclosed in 4-inch PVC pipe connected to a Destron-Fearing FS1001 multiplexing transceiver. Antennas were constructed using methods described in Steinke et al. (2011).

In 2012, the configuration of the instream detection array was changed to six antennas measuring 10 feet long by 3 feet wide, installed in an upstream and downstream array with antennas 1, 2, and 3 upstream (left to right bank) and antennas 4, 5, and 6 downstream (left to right bank), conforming to the PTAGIS protocol. Since inception, all TAN antennas have been installed in a flat plate or pass-over configuration.

TAN was established as a "small-scale interrogation site" in the PTAGIS database. All PIT-tag data collected at TAN were uploaded to PTAGIS weekly. Data for this report were obtained from PTAGIS and were used to determine adult steelhead migration timing, direction of movement, and spawning location. Steelhead tag codes were entered in to the "complete tag history" function and detailed observation records of adult steelhead detections at TAN were downloaded (Table 1).

Table 1. PTAGIS database observation detail of a female steelhead (3D9.1BF258A1C7) detected entering Taneum Creek on May 1 and exiting May 9, 2010.

Event Site Code	Event Site Name	Antenna Group	Antenna	Obs Date Time
TAN	Taneum Creek Instream	DOWNSTREAM ANTENNA	03	5/1/2010 1:43:37 AM
		MIDDLE ANTENNA	02	5/1/2010 1:44:05 AM
		UPSTREAM ANTENNA	01	5/1/2010 1:47:18 AM
				5/9/2010 3:20:55 AM
		MIDDLE ANTENNA	02	5/9/2010 3:21:40 AM
				5/9/2010 3:25:49 AM
		DOWNSTREAM ANTENNA	03	5/9/2010 3:26:57 AM

(A)


(B)


(C)

Figure 4. Taneum Canal Co. diversion dam: (A) showing the location of both PIT-tag antennas; (B) a closeup of TCC1 in the roughened channel fishway; and (C) TCC2 damaged by flood debris.

Results

Results for Objective 1, TCC. In 2012, PIT-tag interrogation equipment operated from February 29 through April 23 when flooding destroyed the antennas (Figure 4-C). The TCC site was repaired and functional again from June 6 until August 24. From then until October 16, the PIT-tag interrogation equipment was functioning, but a corrupt data card led to the loss of an unknown amount of data collected during this time period. No data were collected from October 16 through October 31. The TCC site was functional again from November 1 through December 16 when it was shut down for winter.

During the 2012 season, the TCC detection site recorded 40 unique tag codes (Table 2). The following are descriptions of the complete tag histories for **selected fish** detected at TCC in 2012. These fish were selected to represent the variety of life-stages, species, and seasonal movements observed.

Tag code 3D9.1BF1D48AF9—Rainbow trout tagged in North Fork Teanaway River on February 28, 2012. This was a juvenile fish 154 mm in length and weighing 32.7 g. The fish was detected exiting the Teanaway River array on September 6, and then moved up Taneum Creek where it was detected at TAN on September 26 and TCC on September 27.

Tag code 3D9.1C2D7C88F9—Adult female steelhead tagged at Roza Dam on April 10, detected at TCC on April 21, with the last detection (to date) at the Bonneville Corner Collector on May 24.

Tag code 3D9.1C2D7C8EB5—Adult female steelhead tagged at Roza Dam on April 13, detected at TCC on April 21, and again at TAN on May 8.

Tag code 3D9.1C2D7C9E04—Adult female steelhead tagged at Roza Dam on April 10 and detected at TCC on April 20, but not detected anywhere else.

Table 2. Combined (TCC1 + TCC2) counts of PIT-tags at Taneum Canal Company diversion dam.

Species	2012 TCC Tag Count	2013 TCC Tag Count
Adult Coho	1	0
Juvenile Coho	14	17
Rainbow Trout	20	13
Steelhead	4	7
Cutthroat Trout	1	1
Total Tag Count	40	38

Tag code 3D9.1C2D7CC318—Adult female steelhead tagged at Roza Dam on April 16, detected at TCC on April 22, and again at TAN on May 9.

Tag code 3D9.1C2D7EF319—A naturally produced adult male coho tagged at Roza Dam on October 16, detected at TAN on November 6 and at TCC on November 11.

During 2013 TAN operated from March 15 until March 28. On April 3, a bad solar controller and antenna were replaced and the site was operational until August 7, when a large tree fell on the equipment and damaged the power supply. The diversity of species and counts in 2013 were similar to those observed in 2012 (Table 2); therefore, individual tag history data for 2013 will not be discussed further. The results demonstrated both adult and juvenile fish moved up and down the new roughened channel fishway at the TCC diversion dam throughout the year.

Results for Objective #2, TAN. The TAN site was fully functional in February 2010, but antenna #2 was damaged on May 21 and was not reinstalled until July. Otherwise, the site operated continuously during 2010. During 2011 and 2012, substantial flooding events TAN site (Table 3) compromised operations. In 2011, antenna #2 ceased operating on March 31 followed closely by the loss of #3 on April 4, leaving only one antenna in operation until event on May 15 when flooding destroyed antenna #1. Detection efficiency for the 2011 season was unknown but probably very low, due to high flows and only one functional antenna for much of the time period.

Table 3. Dates of operation for TAN by year.

Year	Dates of Operation
2010	Feb. 18-Dec. 31
2011	Jan. 1- May 15, Aug. 24-Dec. 31
2012	Jan. 1-June 14, Sep. 21-Jan. 31
2013	Jan. 1-Dec. 31
2014	Jan. 1-Dec. 16

The 2012 operations were again compromised by high water events. Antenna #3 was damaged on March 21 and antenna #2 was damaged on April 25. Antenna #1 remained functioning, but developed a slow leak and stopped operating on June 14. The site was reinstalled on September 21 with an upstream and a downstream array constructed out of six 10’-long by 3’-wide antennas enclosed in 4” PVC pipe. The site operated continuously until December of 2014, when TAN was shut down for maintenance. Detection efficiency for adult steelhead in 2013 and 2014 was very high, likely greater than 90 percent, based on radio tags and PIT-tag returns (Zack Mays, WDFW, personal communication).

Table 4. Annual adult steelhead detections at Taneum Creek PIT-tag interrogation site (TAN) and adult fishway counts at Roza Dam on the Yakima River, data from PTAGIS and Yakima Klickitat Fisheries Project websites.

Year	Males	Females	Unknown	Total Count	Roza Dam Count
2010	25	40	1	66	326
2011*	10*	41*	1*	52*	346
2012*	5*	23*	1*	29*	413
2013	18	25	0	43	296
2014	13	42	0	55	376

*Data collected in 2011 and 2012 were compromised by flood events; counts were considered incomplete.

Adult steelhead entered Taneum Creek in mid-March, and exited the creek through early June, with the bulk of the spawning migration occurring from mid-April through mid-May (Figure 5). As the season progressed, fish moved more rapidly from Roza Dam to Taneum Creek (Figure 6), a distance of 38 river miles (61 km). Fish traveled as fast as 19 mi/day (31 km/day) and as slow as less than 1 mile/day (1.6 km/day).

Adult steelhead counts at the TAN site ranged from 29 to 66 during the 2010 to 2014 monitoring period (Table 4). However, as discussed, detection efficiency in 2011 and 2012 was likely compromised by flooding and counts may not represent the total number of tagged fish that entered Taneum Creek. For example, in 2012 there were two adult steelhead detected at the TCC site that were not detected at TAN. Most adult steelhead detected at TAN were tagged at the Roza Dam adult trap (87.7%, n = 215) or at the Prosser Dam adult fishway (9.8%, n = 24), with the remaining fish (2.5%, n = 6) tagged at Priest Rapids Dam, Bonneville Dam, or Prosser Dam juvenile bypass.

It should be mentioned that not every adult steelhead detected at the TAN site spawned in Taneum Creek. Due to the proximity of the site with the Yakima River, some fish entered the creek and left quickly, in some cases less than 24 hours. Occasionally, fish observed at TAN were also observed entering other nearby streams. For example, in 2011, a PIT-tag interrogation site was constructed by WDFW on Swauk Creek (SWK), which enters the Yakima River near Taneum Creek. In each year since, two steelhead detected at TAN were subsequently detected at SWK where they likely spawned. One or two TAN fish also appeared in the Teanaway River (LMT) each year where they likely spawned. However, after examining the observation details for all steelhead detections at TAN, it was concluded that the vast majority of steelhead detected there spawned in Taneum Creek and not elsewhere.

The TAN site also detected adult and juvenile spring Chinook, coho, rainbow/steelhead, and cutthroat trout (Table 6, Figure 8), which were tagged as part of the Yakima-Klickitat Fisheries Project. Although hundreds of juvenile rainbow trout tagged in Taneum Creek migrate downstream annually (Table 6) only one fish tagged in the creek returned as an adult steelhead detected at TAN during the study period.

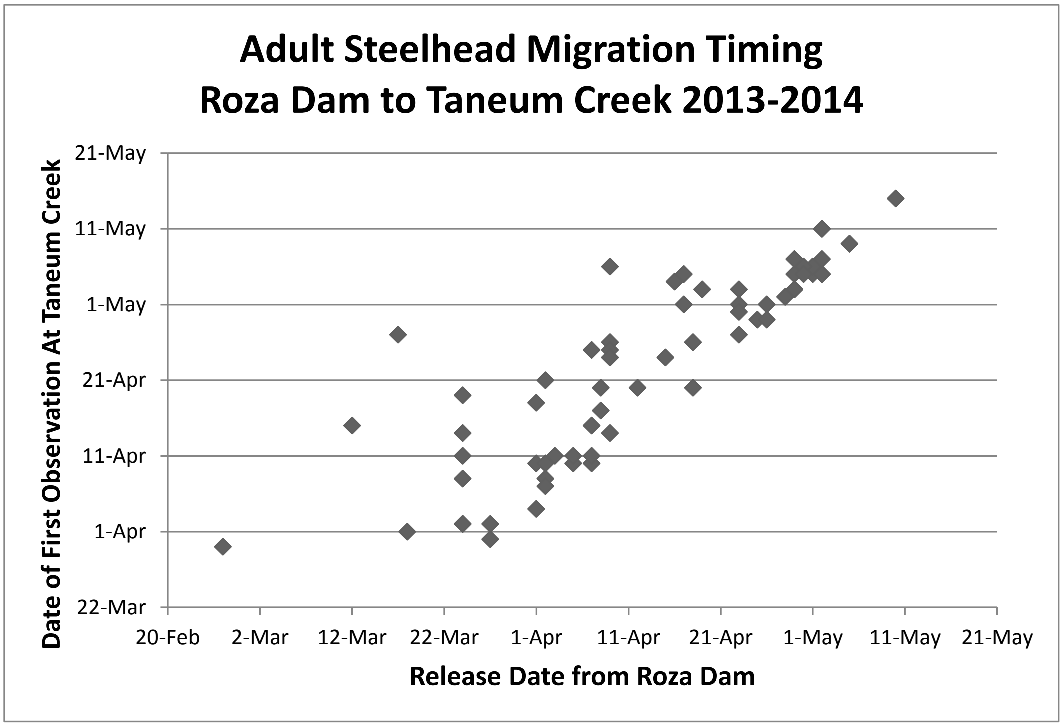

Figure 5. Adult steelhead entered Taneum Creek beginning in late February continuing through mid-May.

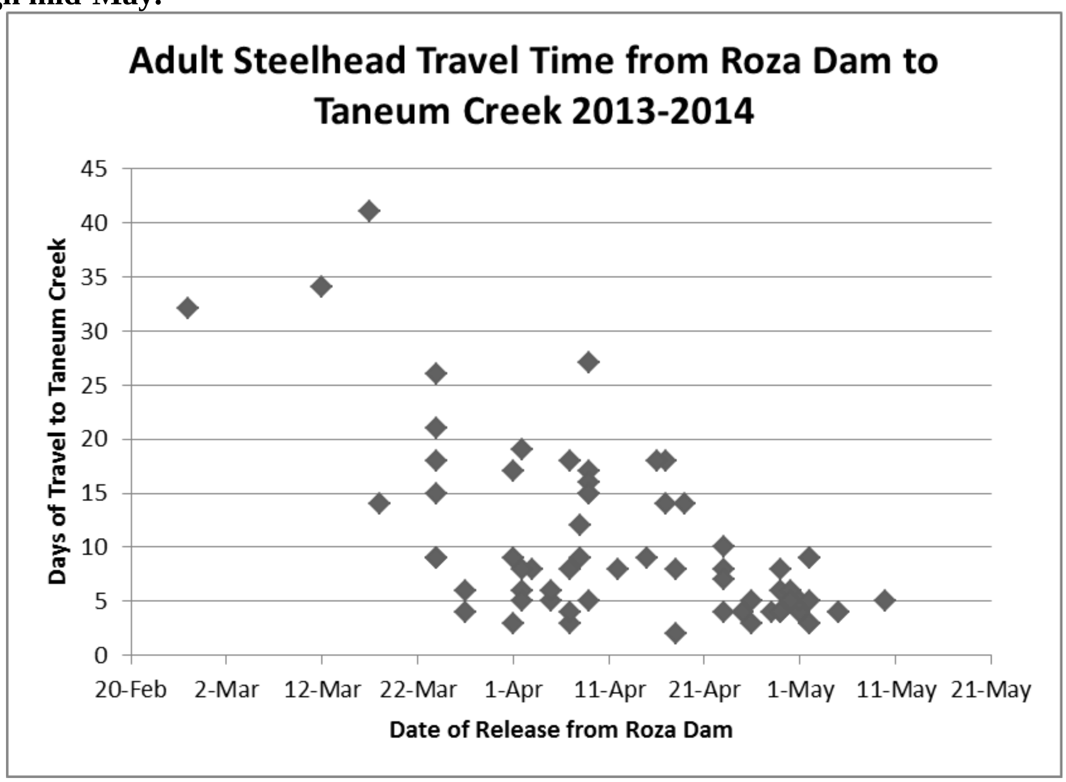

Figure 6. Adult steelhead travel time from Roza Dam to Taneum Creek ranged from 2 days to 41 days. The distance from Roza Dam to the mouth of Taneum Creek is approximately 38 river miles (61 rkm), the rate of travel ranged from 19 miles/day (31 km/d) to less than 1 mile/day.

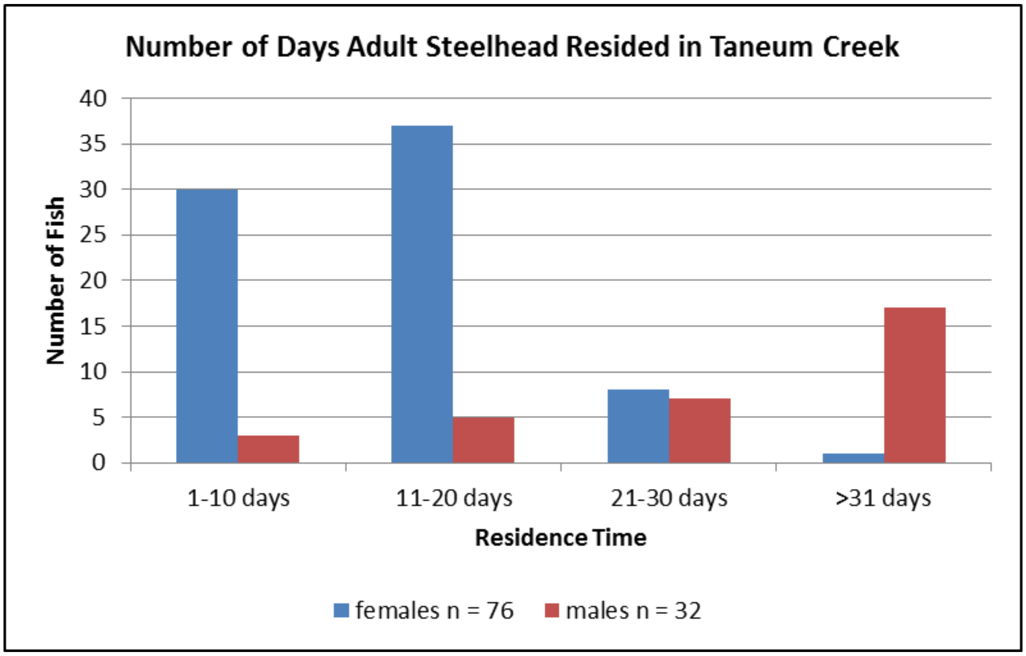

Figure 7. Adult steelhead residence time in Taneum Creek. Females tended to stay in the creek for fewer days than males.

Table 5. Length and weight of adult steelhead returning to Taneum Creek as measured at the time of tagging.

	Females				Males			
	mm	Inches	Grams	lbs	mm	inches	grams	lbs
Max	710.0	28.0	3719.5	8.2	780.0	30.7	5397.0	11.9
Min	540.0	21.3	1496.9	3.3	520.0	20.5	1270.1	2.8
average	591.4	23.3	2191.9	4.8	614.3	23.7	2371.6	4.7

Juvenile fish, tagged annually during the fall months, migrated out of Taneum Creek during the winter and spring (Table 6, Figure 8 below). The peak month for juvenile coho migration was May, while rainbow trout migrated in large numbers in October and again in April-May. In contrast, juvenile spring Chinook tended to exit the creek throughout the fall and winter, prior to the spring freshet. However, these figures have not been adjusted for detection efficiency and may not represent the true proportions of migrants by month. Few fish were detected in July and August, because seasonal downstream movements had ended, and because tagging occurred in the fall.

Table 6. Total counts of unique tag codes detected at TAN by year and species.

Year	Coho Juvenile	Coho Adult	Spring Chinook Juvenile	Spring Chinook Adult	Rainbow/ Steelhead	Cutthroat Trout
2010	635	1	5	1	158	0
2011	195	1	115	0	159	4
2012	107	26	85	0	222	13
2013	273	10	96	0	335	7
2014	708	3	84	0	445	27

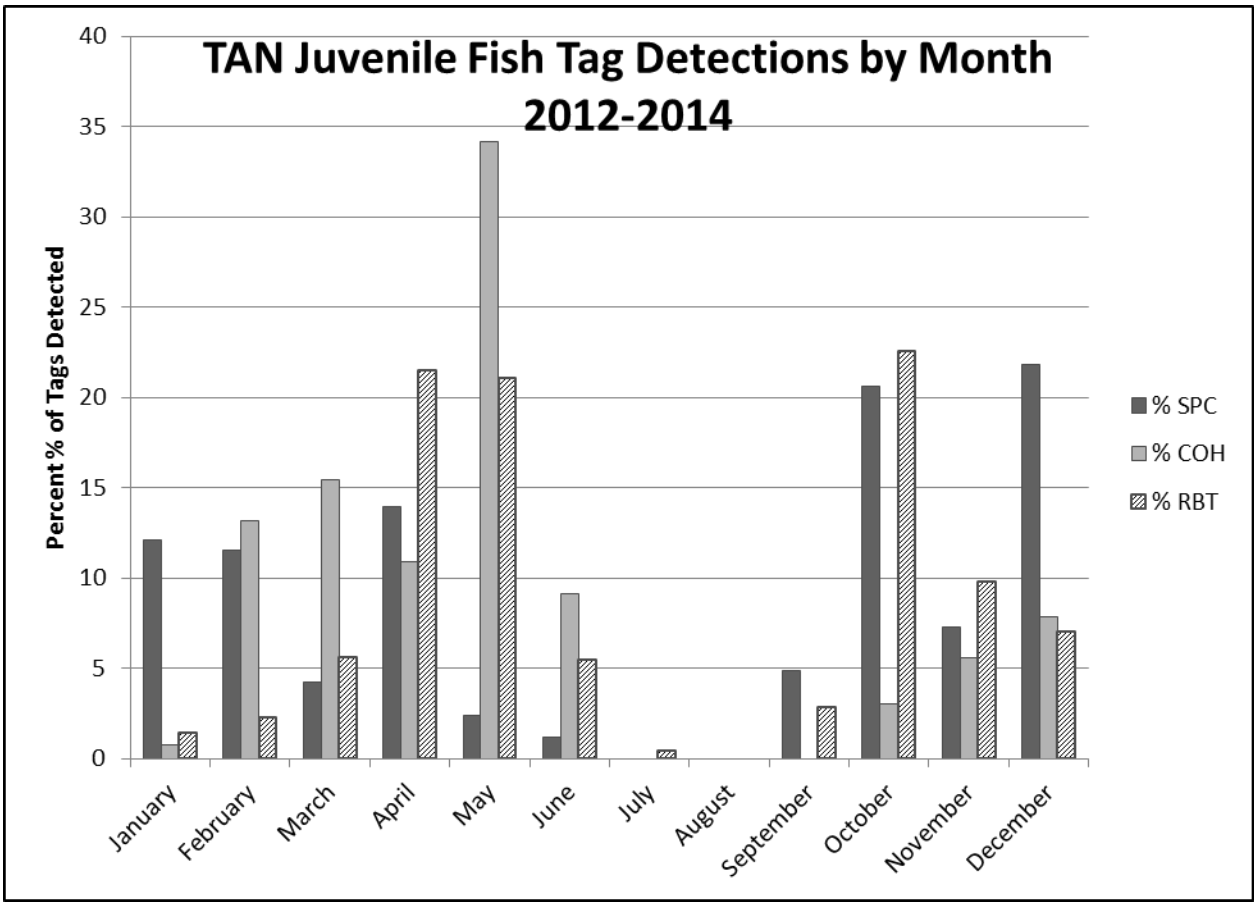

Figure 8. The percent of juvenile fish tags detected by species and by month at TAN for spring Chinook (SPC, n = 165), coho (COH, n = 395) and rainbow trout (RBT, n = 912) during 2012-2014.

Discussion

Recent PIT-tag monitoring found between 29-66 adult steelhead detected at the mouth of the creek annually, most of which spawned there, representing about 15% of the 2010-2014 upper Yakima River steelhead run. Adult steelhead returns to the upper Yakima River were monitored at the Roza Dam fishway from 1940-1967 (Cramer et al. 2004) and from 1981 until the present (Fredericksen et al. 2014). Only a remnant population of adult steelhead returned to upper Yakima River during the monitoring period, ranging from zero to 408 fish. Since 2004 the upper Yakima River steelhead run has averaged 233 wild fish.

Taneum Creek supported little or no steelhead production as recently as the early 1980's (Campton and Johnston 1985). In 1993 a fish trap was operated by WDFW near the mouth of Taneum Creek during April and May, catching three adult steelhead. One went upstream to spawn while two spawned at the mouth of the creek (Hockersmith et al. 1995). From 2002-2006, a radio-tagging study monitored 17 steelhead entering Taneum Creek out of 353 fish tagged at Roza Dam (Karp et al. 2009). Extrapolating from those data, steelhead escapement to Taneum Creek during the study period would have been approximately 8 fish per year, or about 5% of the upper Yakima River run. Steelhead are now returning to Taneum Creek in greater abundance than the recent past, having naturally recolonized the creek. However, the increase coincided with a Yakima basin-wide improvement in steelhead returns (Fredericksen et al. 2014) suggesting factors during migration and ocean conditions have also influenced recent returns. Thus, a longer monitoring period will be required to determine how steelhead respond to variations in environmental conditions.

The recovery of steelhead runs following habitat restoration has been documented elsewhere in the Columbia River basin. A recent study monitored fish returns to Beaver Creek, a tributary to the Methow River in northern Washington (Martens and Connelley 2010; Weigel et al. 2013). Beaver Creek was similar to Taneum Creek in that anadromous fish had been extirpated from the watershed and recent fishery restoration projects included removing passage barriers and restoring instream habitat conditions. Following these actions fish runs were monitored and genetic samples were collected from steelhead and rainbow trout. Researchers found steelhead rapidly recolonizing Beaver Creek—they migrated into the stream the first spawning season it was accessible and expanded their distribution to the whole watershed in a few years. Genetic samples showed the wild steelhead originated from rainbow trout in Beaver Creek, and were not related to steelhead that had strayed in to the creek from a nearby hatchery program (Weigel et al. 2013). Once connectivity was reestablished, steelhead naturally recolonized Beaver Creek.

The biological mechanism of steelhead recolonization of Taneum Creek remains undetermined. Anadromy is a complex suite of traits, which includes the ability to migrate downstream, adapt from freshwater to saltwater and back again, navigate the ocean, and home to the natal spawning stream. Such complex traits involve many genes with important developmental, physiological, and behavioral functions (Nichols et al. 2008, Hecht et al. 2012). Population genetics suggests that complex traits like anadromy are conserved and unlikely to be lost, even in small populations (Cramer et al 2004, Holocek et al. 2012). It is possible that adult steelhead returned as a remnant population to the lower mile of Taneum Creek for decades, and underwent a population expansion following the removal of migration barriers. It is also plausible that rainbow trout in Taneum Creek produced some anadromous offspring that survived, returned, and reproduced once migration conditions were improved. The ability to produce anadromous offspring has been observed in rainbow trout populations isolated in freshwater (Thrower et al. 2004, Van Doornik et al. 2013) as well as populations which were isolated and regained access to the ocean (Riva-Rossi et al. 2007). Courter et al. (2013) found a significant proportion (7-20%) of adult steelhead kelts collected at Prosser Dam in the lower Yakima River had a female resident parent. Pearsons et al. (1998) observed rainbow and steelhead spawning together, concluding that they interbred and shared a common gene pool in the upper Yakima River. Additionally, adult steelhead could have strayed in to Taneum Creek from elsewhere. For example, some radio-tagged steelhead (predominantly males) were observed in more than one stream in the upper Yakima River during the spawning period (Zack Mays, WDFW, pers. comm.), indicating they may have spawned in multiple locations. Regardless of origin, once steelhead regained access to Taneum Creek they likely produced offspring with a greater propensity to migrate to sea (Hayes et al. 2012) which, along with favorable freshwater and ocean survival conditions, allowed steelhead to return to the watershed in greater numbers.

A unique aspect of steelhead biology in relation to other Pacific salmonids is the ability to repeat spawning. Figure 9 below shows the passage route and PIT-tag detection locations for a wild female steelhead tagged at Roza Dam on April 4, 2011. After being tagged it went upstream to Taneum Creek and spawned, returning to do so again in 2013. Repeat spawning was only observed for two other steelhead during the study period, one a fish that spawned in 2010 and 2011, and another fish that spawned in 2011 and 2012. These fish underwent a journey within the Columbia and Yakima rivers of over 1,400 miles in length, highlighting the importance of having safe passage at man-made dams and structures for fish to survive such a protracted migration.

Most spring Chinook, coho, and rainbow trout detected at the TAN site were juveniles migrating downstream (Table 6). Adult spring Chinook do not spawn in Taneum Creek, but juveniles can swim up the creek from the Yakima River. Juvenile Chinook are mainly found in the lower 2.5 miles of the creek (Tim Webster, WDFW, pers. comm.). Juvenile coho were predominantly the progeny of adults that were transported in to the creek as part of an experimental salmon reintroduction program conducted by YKFP (Bosch et al. 2007; Temple et al. 2011). PIT tag counts of naturally produced adult coho that returned from the reintroduction program ranged from 1-26 during the monitoring period (Table 6).

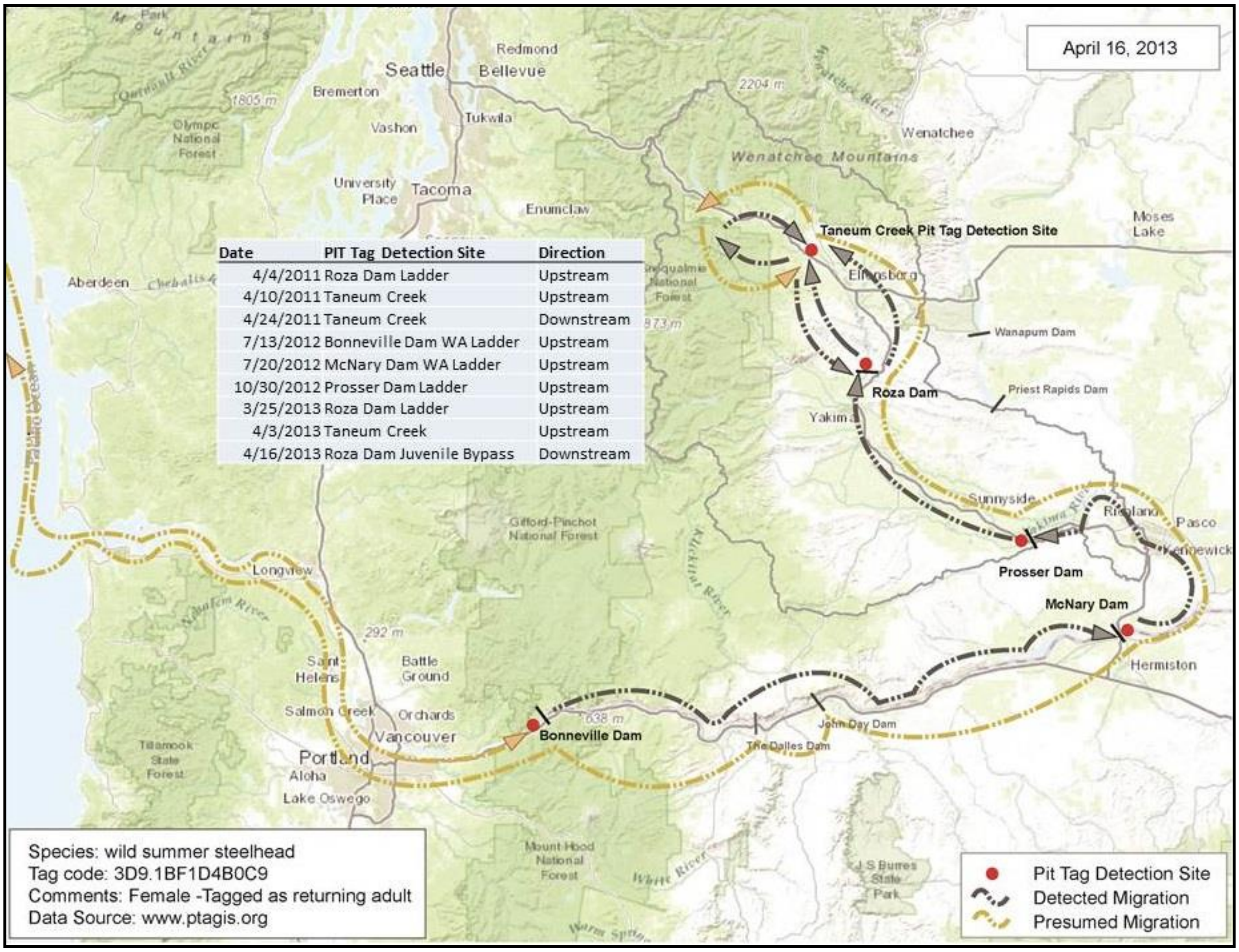

Figure 9. The passage route of a wild summer steelhead that spawned in Taneum Creek in 2011 and was observed spawning again in 2013 (figure by C. Krider, Yakima Basin Fish and Wildlife Recovery Board).

Conclusions and Future Directions

This report was prepared as part of an effort to monitor fish responses to habitat improvements in Taneum Creek and was funded by Reclamation-YRBWEP under the Tributary Enhancement authority, Section 1207 of Title XII, Public Law 103-434 and by the YKFP. Many funding sources were invovled in habitat restoration actions.

The discussion focused on adult steelhead returns to Taneum Creek because they are listed under the ESA and many habitat improvement projects were implemented in-part as steelhead recovery actions. A comprehensive steelhead "Viable Salmonid Population" monitoring program is being conducted by YN Fisheries and WDFW to evaluate steelhead production and productivity throughout the Yakima Basin (Frederiksen et al. 2014). Data collected at the TAN site will contribute to that project. A key question will be whether or not Taneum Creek steelhead abundance increases, decreases, or reaches an equilibrium level over time.

Taneum Creek provides an example of steelhead recovery occurring through the natural ability of fish to recolonize habitat following the removal of passage barriers and the restoration of instream habitat conditions, but continued monitoring is recommended to determine steelhead responses to environmental variations. Other Kittitas Valley tributaries such as Coleman, Wilson, Manastash and Naneum creeks have intact headwaters but remain disconnected from the Yakima River. Unscreened water diversions, canal-creek intersections, and infrastructure such as road culverts continue to pose migration barriers to fish. Reestablishing connectivity and restoring habitat within tributaries will likely further steelhead trout recovery in the upper Yakima River basin.

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Appendix

Date	Time	Taneum Canal Co. PIT TAG Codes
10/19/2011	11:29:43.TC1	3D9.1C2C575A59
10/19/2011	11:30:08:TC2	3D9.1C2C9257CE
11/3/2011	16:07:51:TC2	3D9.1C2D8015D7
1/4/2012	22:01.8	3D9.1C2C583BA3
2/29/2012	18:30:17:TC2	3D9.1BF1B68888
3/2/2012	06:52:59:TC2	3D9.1C2D34B7CB
3/2/2012	18:36:26:TC2	3D9.1BF1CFB270
3/3/2012	06:17:45:TC2	3D9.1C2D34B563
3/3/2012	06:26:52:TC2	3D9.1BF1CFD3A5
3/3/2012	18:36:03:TC2	3D9.1C2D841990
3/4/2012	14:05:39:TC2	3D9.1BF1D47528
3/6/2012	05:48:08:TC2	3D9.1BF1D4D499
3/6/2012	22:25:54:TC2	3D9.1C2D8800DB
3/8/2012	03:49:08:TC2	3D9.1C2CF65B0B
3/9/2012	03:15:42:TC2	3D9.1C2D7FCCA6
3/9/2012	18:26:24:TC2	3D9.1C2D7FECB9
3/13/2012	16:50.8	3D9.1C2D7F9E80
3/14/2012	19:17:28:TC2	3D9.1BF1457851
3/21/2012	22:47:35:TC2	3D9.1C2D760B62
3/27/2012	11:21:20:TC2	3D9.1C2C480E9E
3/28/2012	19:31:28:TC2	3D9.1C2D3516AD
3/30/2012	02:16:35:TC2	3D9.1C2D844410
3/31/2012	16:07:50:TC2	3D9.1C2C4F3FF3
4/1/2012	19:14:49:TC2	3D9.1C2D840A23
4/2/2012	19:45:19:TC2	3D9.1C2C4EE71A
4/3/2012	20:34.8	3D9.1C2D7FEC0F
4/12/2012	10:49.5	3D9.1C2C91B2D8
4/20/2012	16:12:34.TC1	3D9.1C2D7C9E04
4/20/2012	21:51:56:TC2	3D9.1C2C4EFDCB
4/21/2012	16:04:54.TC1	3D9.1C2D7C88F9
4/21/2012	16:23:39:TC2	3D9.1C2D7C8EB5
4/21/2012	19:39:34:TC2	3D9.1C2C50B5DA
4/21/2012	19:44:56:TC2	3D9.1C2D8A6750
4/22/2012	10:09:11.TC1	3D9.1C2D7CC318
4/22/2012	19:24:52:TC2	3D9.1C2C4EEFE1
4/23/2012	05:00:12.TC1	3D9.1C2D806C2F
7/9/2012	20:38:52.TC1	3D9.1C2D809412
9/27/2012	11:19:08.TC1	3D9.1BF1D48AF9
11/2/2012	18:29:20:TC2	3D9.1C2D86AE72
11/3/2012	18:45:32:TC2	3D9.1C2C4F38A7
11/4/2012	04:51:27:TC2	3D9.1C2D7EF319
11/6/2012	23:54:14:TC2	3D9.1C2D75E419
11/7/2012	23:50:45:TC2	3D9.1C2D34C1F3
11/20/2012	21:14:35:TC2	3D9.1C2DB6294A
11/30/2012	19:03:52:TC2	3D9.1C2D867A8C
3/16/2013	12:21:07:TC2	3D9.1C2DBC4B64
3/17/2013	00:55:30:TC2	3D9.1C2D26F356
3/17/2013	19:24:58:TC2	3D9.1C2D26D159
3/19/2013	02:06:07:TC2	3D9.1C2D350D96
3/19/2013	23:28:44:TC2	3D9.1C2D35136E
3/22/2013	20:23:19:TC2	3D9.1C2DB6D1C3

3/23/2013	21:14:39:TC2	3D9.1C2D34B54A
3/25/2013	01:41:04:TC2	3D9.1C2D34B254
4/4/2013	05:42:51:TC2	3D9.1C2D3531FF
4/9/2013	01:05:10:TC2	3D9.1C2D84750D
4/11/2013	03:26:53:TC2	3D9.1C2D842FBE
4/17/2013	00:41:12:TC2	3D9.1C2A6AB2BA
4/4/2013	19:08:35:TC1	3D9.1C2D276489
4/5/2013	19:12:48:TC1	3D9.1C2D373700
4/8/2013	14:20:16:TC1	3D9.1C2D34BB76
4/8/2013	18:24:10:TC1	3D9.1C2DBBE200
4/16/2013	04:59:10:TC1	3D9.1C2DB60F91
4/16/2013	22:46:07:TC1	3D9.1C2D34B638
4/19/2013	19:42:30:TC1	3D9.1C2D35085B
4/20/2013	14:10:25:TC1	3D9.1C2D83FCF4
4/22/2013	20:47:08:TC1	3D9.1C2D81A3BC
4/24/2013	16:53:50:TC1	3D9.1C2D7FD0CB
4/26/2013	02:14:14:TC1	3D9.1C2C50BDC3
4/26/2013	14:44:57:TC1	3D9.1C2D7FA21C
4/27/2013	19:42:26:TC1	3D9.1C2DB694BE
4/28/2013	00:18:24:TC1	3D9.1C2D840071
4/29/2013	16:29:57:TC1	3D9.1C2D34C6E3
4/30/2013	13:05:09:TC1	3D9.1C2D800366
5/3/2013	20:57:34:TC1	3D9.1C2D800165
5/4/2013	17:03:37:TC1	3D9.1C2D7F34FA
5/4/2013	18:15:51:TC1	3D9.1C2D7FA6DD
5/4/2013	20:00:23:TC1	3D9.1C2D34B7FB
5/4/2013	21:02:23:TC1	3D9.1C2D7FC69C
5/5/2013	10:06:42:TC1	3D9.1C2D7EA0DA
5/5/2013	12:48:17:TC1	3D9.1C2D7E7981
5/5/2013	15:34:35:TC1	3D9.1C2CF0A6AC
5/6/2013	14:20:08:TC1	3D9.1C2D7F2167
5/7/2013	01:42:13:TC1	3D9.1C2D34B24B

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