Report on Oregon Spotted Frog egg mass surveys 2013-2015

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Introduction

Oregon spotted frogs (*Rana pretiosa*) were once common across wetlands throughout western Washington and Oregon and were found in northern California and southern British Columbia. It is believed that they are now present in less than 20% of their historic range (Hayes 1997), and many of the remaining populations have dwindled to very low numbers. As a result of rapidly declining populations, Oregon spotted frogs were Federally listed as Threatened under the US Endangered Species Act in August 2014 (USFWS 2014). They have been listed as Endangered by the State of Washington since 1997 (WDFW 2011).

One of the main challenges for Oregon spotted frogs range-wide is the loss and degradation of the large wetland complexes that are their preferred habitat (McAllister et al. 1993; Hayes 1994a, b; Hayes 1997). Other things that may harm Oregon spotted frogs include invasive plants like reed canary-grass (*Phalaris arundinacea*) (Kapust et al. 2012); introduced predators such as American bullfrogs (*Lithobates catesbeianus*) and warm water fishes (Hayes & Jennings 1986, Adams et al. 2003); removal of natural disturbance regimes including fires, floods, and beavers that historically maintained open wetlands (Watson et al. 2003); and changes to the natural hydrologic cycle as a result of dams, climate change, or wetland alterations (Adams 1999).

Oregon spotted frogs are found throughout the wetlands on Conboy Lake National Wildlife Refuge (CLNWR). The population of Oregon spotted frogs at Conboy Lake is one of the larger remaining populations, and one of very few throughout the species range that have persisted following the introduction of bullfrogs. There are several possible reasons for the continued survival of Oregon spotted frogs at CLNWR. The most important is probably that Conboy Lake is a large, relatively intact wetland complex that provides the habitat required for all life stages of frogs. How they persist with bullfrogs is a more complicated question, but may be a result of the cold winters and short growing season, which favor Oregon spotted frogs. The variety of habitats available also might allow the two species to coexist. Brown bullheads (*Ameiurus nebulosus*) are also present on the Refuge in large numbers, but their effect on Oregon spotted frogs is largely unknown. Unfortunately, like many Oregon spotted frog populations, the numbers of frogs on Refuge have declined, although the exact reasons for the decline are unclear.

To understand population trends and potential effects of management actions on the Oregon spotted frog population at CLNWR, annual surveys for egg masses have been conducted on all or part of the Refuge since 1998. Egg mass surveys provide an estimate of total adult population size based on the assumption that each egg mass represents one breeding female and one breeding male (Phillipsen et al. 2009).

The egg mass count declined precipitously between 1998 and 2001. This decline prompted a number of projects to improve water management capabilities and studies to understand habitat use and movement of Oregon spotted frogs. Since 2001, egg mass counts have been more consistent but still exhibit an overall negative trend. From 2006 through 2008, funding cuts prevented refuge-wide egg mass surveys. A subset of wetlands identified as representative of the refuge were surveyed. From 1998 through 2012, egg mass surveys were organized and led by staff from the Washington Department of Fish and Wildlife. Reports on 2009 through 2012 egg mass surveys written by WDFW staff are available (Hayes 2010, Hayes & Hicks 2011, Hayes & Hicks 2012). Refuge staff took over egg mass surveys in 2013 following the same protocol as previous surveys.

Survey Method

Depending on weather conditions and water temperatures, egg mass deposition can begin any time between the end of February and mid-March. Beginning in late February, Refuge staff check nearly daily in known early deposition areas for the first egg masses. Once we find the first egg masses, we schedule Refuge-wide surveys to begin about a week later. The main area checked for initial oviposition is the west side of C&H South.

We conduct surveys by searching all appropriate oviposition habitat, which includes still water less than about 0.4 m in depth with little to no shading from trees and shrubs. We typically do not search areas with very dense vegetation like cattails and bulrush. We search large areas by transects, often with several surveyors. When egg masses are found, we count them and record the position with GPS. We collect data in ArcPad using a Trimble GPS unit. Aside from location, recorded data include the count of egg masses, the general developmental stage on a 1 to 4 scale, and any notes on excessive mortality or other abnormal features. We also record the number of surveyors and weather conditions, including wind speed on a Beaufort scale, precipitation, and general survey quality. We may stop surveys due to weather conditions, such as wind and rain, if conditions prevent surveyors from seeing egg masses. We visit most wetlands a second time to check for new egg mass deposition and remove pin flags.

We conduct the surveys over approximately 4 weeks. Weather can alter the time-frame of surveys; warm weather will reduce the time until hatching or excessive rain and cold can lengthen the survey period. We have designated some wetlands as “early” and others as “late” to help time visits (Table 2). The C&H units are usually early. Oxbow, Arena, and Kelley Main are also usually early. Conboy Lake, Camas East, Kelley North, Bird Creek NW, and Laurel West are usually later units. Other units, especially Troh and Camas West, fall somewhere in the middle and may have egg deposition over a longer period than smaller units. Although there are general trends, timing within a unit may vary as a result of changes in vegetation, water depth, or flow characteristics.

Results

The total egg mass counts for 2013 through 2015 are summarized in Table 1. Counts for these years remain on the low side, although all years are higher than the lowest count of 977 in 2012. Most notably, the egg mass count for the subset of wetlands that was surveyed in 2006-2008 did not decline between 2014 and 2015. This represents the first year since 2008 that the count did not decline (Fig. 1). While the Refuge total was more consistent during this time, the count for Refuge units that were part of the Refuge in 1998 still exhibits a downward trend. Even when the peak years of 1998-2000 are excluded, linear regression of all metrics of egg mass numbers exhibit a negative slope (Fig. 2).

The largest change in egg mass numbers lies mainly in the Kelley units. Egg mass counts in Kelley Main increased dramatically, from 52 in 2010 to over 330 in 2014 and 2015. Kelley North was constructed in 2014 and contained 43 egg masses in 2015.

Most units aside from the Kelley units are in the lower end of the range of previous egg mass counts. Egg mass counts for select units from 1998 through 2015 are summarized in Table 1. The Laurel West unit had egg masses in 2013 for the first time since 2006. Egg mass counts in Laurel East declined dramatically between 2013 and 2015.

Discussion

Some declines, such as that observed in Laurel West, have a clear cause. In that case, a beaver dam that historically checked Chapman Creek and maintained a constant water level was destroyed and breeding habitat subsequently decreased, along with the likelihood of juvenile survival. In many other units, the continued decline has no obvious cause. One possibility is that water management prior to about 2012 did not allow Oregon spotted frog tadpoles sufficient time for metamorphosis in all units or provide a path of dispersal. Beginning in 2013, wetland draw-down dates were pushed back to allow metamorphosis. If water management regimes have improved survival, we should begin to see an increase in egg mass numbers in those managed units in 2016 as frogs reach maturity.

Another possible influence on the Oregon spotted frog population is any change in predators, particularly American bullfrogs. While bullfrogs and brown bullhead have been present in the Glenwood Valley since the 1950's and probably quickly reached large population sizes, their maximum adult size and total population have been kept in check by climatic conditions. American bullfrogs are more susceptible to freezing and winter-kill than spotted frogs. Short growing seasons reduce maximum adult size of bullfrogs, which limits predation on adult Oregon spotted frogs. As winters become less harsh with less snowfall and as the growing season becomes longer, bullfrog populations may survive in larger numbers and individuals may reach a larger average adult size, which could result in increased predation on Oregon spotted frogs.

The egg mass count increase in the Kelley Main wetland is interesting. It is likely that this unit, being a completely unmanaged wetland, is more susceptible to a natural boom and bust cycle. Higher counts in 2014 and 2015 may be peaks from a few good recruitment years with more low counts likely in the future due to natural variability. Further increases in egg mass numbers in this unit are not anticipated.

Conboy Lake continues to be a disappointing wetland for Oregon spotted frog breeding. The only possible reason for low egg mass counts that I have identified is the large water level fluctuations that often occur during oviposition and egg development. Additionally, some frogs may have switched to other sites as vegetation in Conboy Lake has become less than ideal. Vegetation management and removal of movement barriers conducted in summer 2015 should improve habitat conditions. Large changes in water levels may be unavoidable, but the elevation of rocked spillways will be adjusted to try to reduce the magnitude of change. The spillways have likely subsided over time, making them too low to function appropriately.

Water level fluctuations are a problem in other units including Oxbow, Kelley Main, Camas South, and, to a lesser extent, Camas West and East. Water level fluctuations are probably historically a natural occurrence, but the drastic changes observed currently are exacerbated by the man-made drainage system. Spillways were raised in Oxbow in 2014 and appeared to reduce fluctuations in 2015, but any effect on frog populations will not be observed for several years.

Refuge staff disked Willard Pond and C&H West this year to improve habitat conditions for all life stages of Oregon spotted frogs by reducing vegetative cover, particularly tall emergent vegetation such as cattail. Disking mimics disturbances that have otherwise been removed from the system. The response of Oregon spotted frogs to the Kelley North wetland suggests that the species is more tolerant of and reliant on disturbance than generally thought.

Since it is my first opportunity to summarize egg mass data, a discussion of some potential relevant events is worthwhile. The egg mass counts in 1998 were probably unusually high and not a typical number. Two potential causes have been identified: 1) the 1996 floods and generally high water, or 2) a beaver dam in Camas Ditch that was removed in 1997. There is no way to know what the population was prior to 1998 or if these events influenced the egg mass count. However, it is unlikely that egg mass counts will ever reach 7,000 under normal conditions.

We are anticipating higher egg mass counts in 2016 in Camas East and some of the C&H units following habitat improvements and changes to water management. Egg mass counts in Willard and Troh should increase in the following years due to similar habitat management implementation. We plan to continue the current water regime for the next several years. Other future habitat improvement projects in the Bird Creek NE area and in the Chapman units, which have recently had few to no egg masses, should improve overall counts. Ongoing invasive

species control efforts to reduce bullfrogs and brown bullhead and other non-native fish should improve recruitment of Oregon spotted frogs across the Refuge.

It is noteworthy that a significant source of the overall decline in egg mass numbers is accounted for by declines in Camas South, Myer, and Swan wetlands. These wetlands are similar in their lack of summer water inputs; they all rely on precipitation to fill and are not supported by the irrigation system that feeds Refuge wetlands north of Outlet Creek and Camas Ditch. Additionally, the Camas South wetland has significant issues with shared water management. Water management in Myer is also shared, but it is partially managed by Refuge staff. Swan Lake is controlled solely by the Refuge. It is interesting to note that while Camas South continues to have nearly no oviposition, Swan Lake has supported some Oregon spotted frog reproduction in recent years. Myer has been variable, but has improved somewhat from a low of 0 in 2001.

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Table 1. Oregon spotted frog egg mass counts on Conboy Lake NWR for 1998 – 2015.

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Total Refuge Count	7018	5434	2714	1400	1442	1997	3178	3100				1295	1665	1312	962	1357	1244	1267
Subset (C&H, Conboy, Laurel W, Troh)	1225	1150	1000	500	873	1163	1271	998	511	233	395	781	583	502	404	345	259	259
Pre-2006 Comparison[1]												1295	1613	1170	842	1160	909	887
Camas West[2]	924	850	305	161								125	297	37	93	328	173	270
Camas East[2]	364	125	81	109								93	129	102	84	82	24	26
Camas South[2]	1121	345	103	0		3	79					1	7	1	0	9	0	0
C&H South						266	165					205	149	117	103	86	66	93
C&H All	499	703	572	438	272	339	345	395	282	146	115	476	256	164	172	157	146	141
Oxbow	52	100	38	7		154	199					114	186	210	180	99	72	90
Swan Lake						100	129					30	46	17	28	75	44	42
Myer												0	81	2	19	1	3	18
All Myer & Swan[2]	1052	866	386	9								83	174	46	46	93	47	60
Arena	120	123	11	0								14	39	35	35	40	70	66
Troh	700	429	220	189	345	489	567	317	143	47	190	137	152	193	106	123	91	91
Conboy Lake[2]	803	830	193	242	178	255	314	270	85	40	90	168	175	145	128	59	11	22
Willard[2]	488	588	336	202								15	19	45	13	61	49	32
Laurel West					78	80	45	15	1	0	0	0	0	0	0	6	11	5
Kreps Lane Units	440	68	95	30								0	30	29	14	19	12	12
Kelley Main[3]													52	142	120	197	335	337
Kelley North[4]																		43

1. Pre-2006 Comparison includes only those units that were part of the Refuge and surveyed in 1998. This excludes the Kelley wetlands.

2. Naming conventions for 1998-2001 were different, and areas defined may or may not be exactly as defined in subsequent years. Some combined units (Myer & Swan, C&H All) are included when individual unit information is not available for all years.

3. The Kelley unit was acquired in 2006 and was not surveyed until 2010.

4. The Kelley North wetland was constructed in 2014. There was not oviposition habitat in that area to survey prior to 2015.

Table 2. General timing of egg mass deposition by wetland unit. These are subject to a variety of changing conditions and may not always be accurate. Some units, particularly larger ones like Camas West and Troh, may have egg mass deposition over several weeks and require multiple visits. Some wetland units that have not supported Oregon spotted frog reproduction in recent years have not been included.

Parent Unit	Unit Name	Timing
Arena	Arena	Early
Bird Creek	Bird Creek NW	Late
C&H	C&H North	Early-Middle
	C&H South	Early
	C&H West	Early
	C&H East	Early-Middle
Camas Lake	Camas East	Late
	Camas SE	Early
	Camas West	Early
	Willard Pond	Middle-Late
Chapman	Chapman North	Early
	Chapman South	Middle
Cold Spring	Aspen	Early
	Cold Springs E	Middle
Conboy Lake	Conboy Lake	Late
	ConTrohM	Middle
Kelley	Kelley Main	Early
	Kelley North	Late
Laurel	Laurel East	Middle
	Laurel West	Late
Myer	Myer	Middle
	Myer West	Early
	Swan Lake	Middle
Other	Road NE	Middle
Oxbow	Oxbow	Early
Private	Cross	Middle
	Ladiges	Early
Troh	Troh	Middle
	Troh Pond	Middle
	Troh SW	Middle

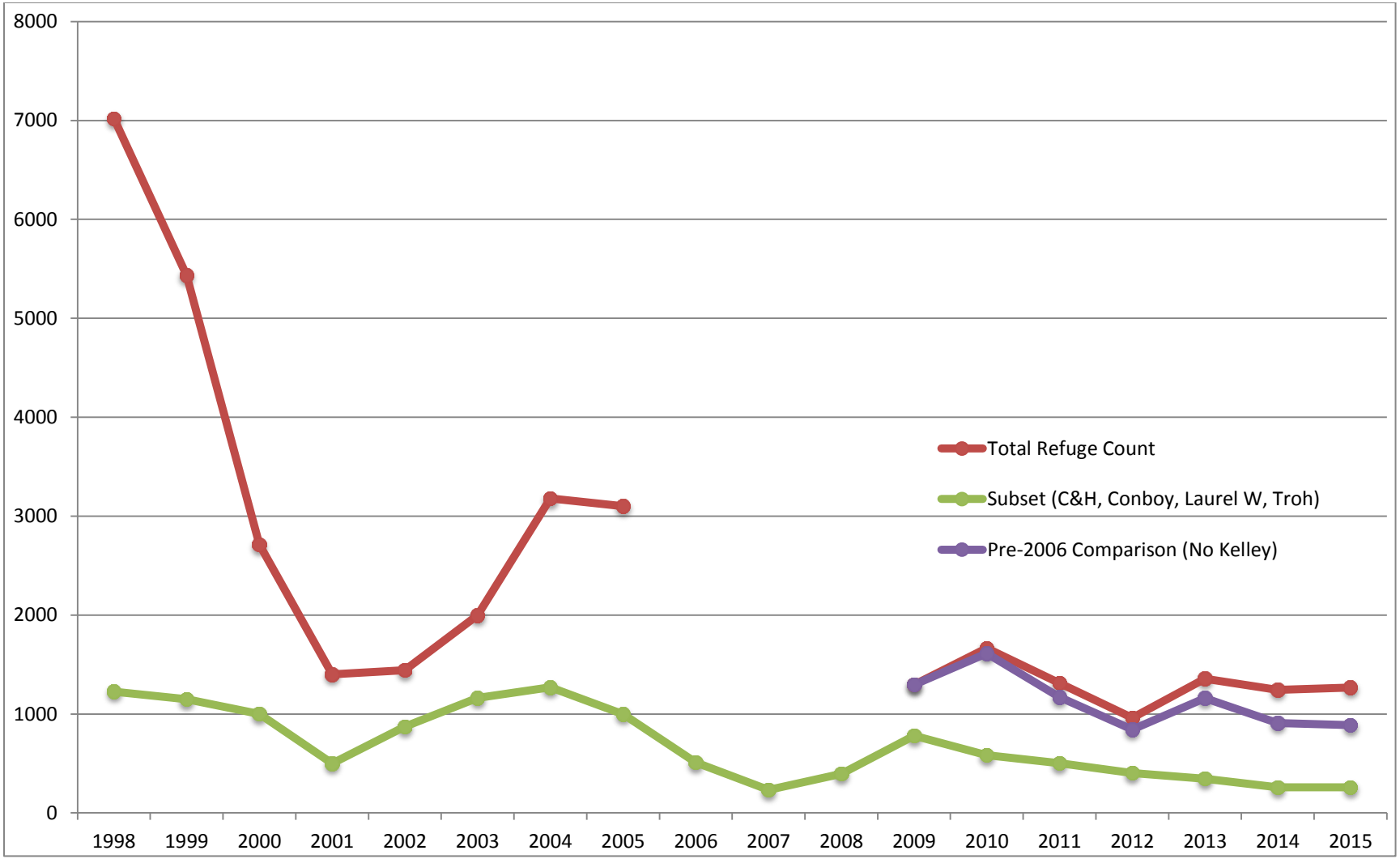

Figure 1. Oregon spotted frog egg mass numbers from 1998-2015 for the entire refuge; a subset of wetlands including the C&H units, Conboy Lake, Laurel West, and Troh; and wetland units that were included within the Refuge in 1998, which excludes all Kelley wetlands.

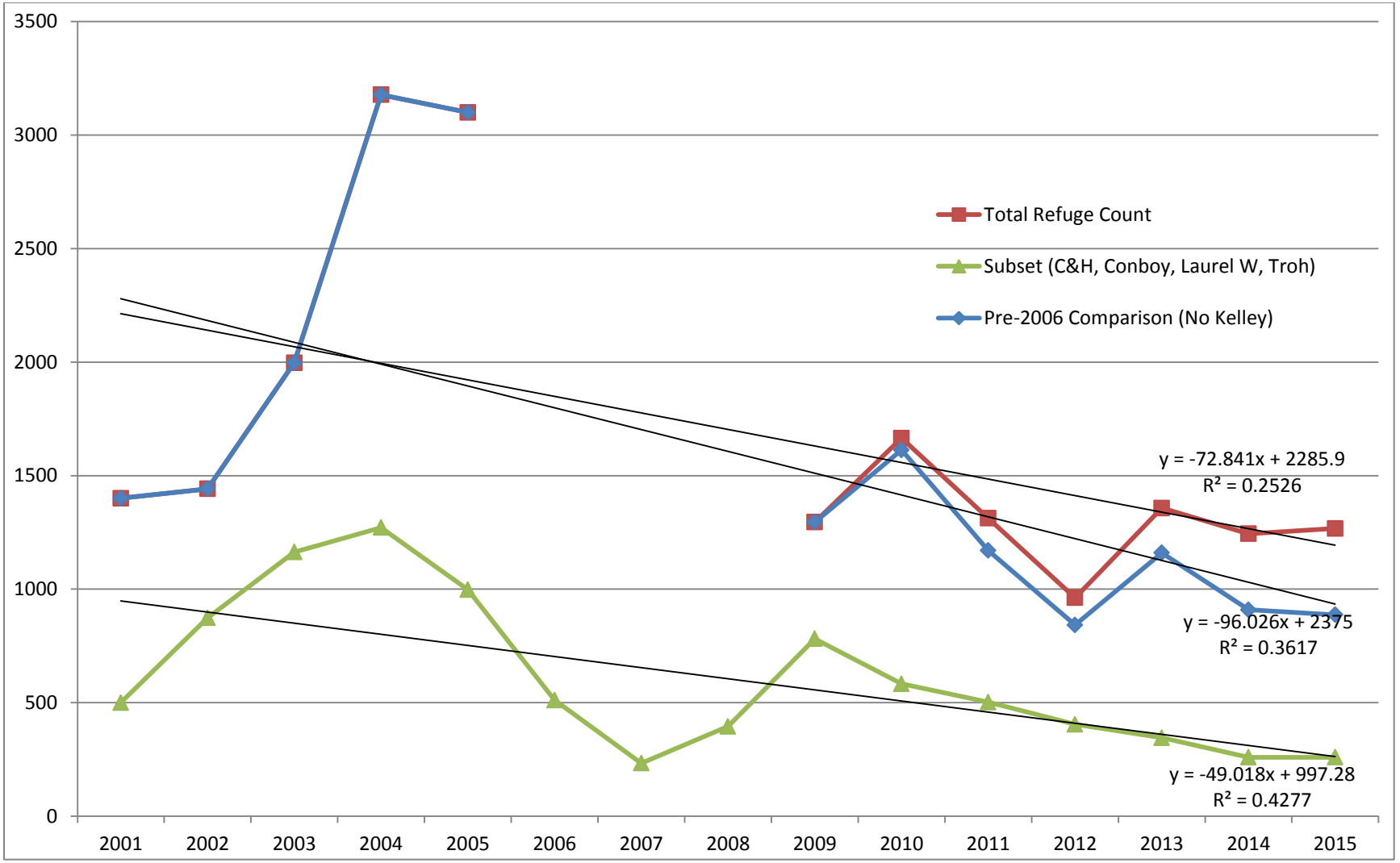

Figure 2. Oregon spotted frog egg mass numbers with simple linear regressions from 2001-2015 for the entire refuge; a subset of wetlands including the C&H units, Conboy Lake, Laurel West, and Troh; and wetland units that were included within the Refuge in 1998, which excludes all Kelley wetlands.