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PROJECT TITLE:
Population genetic analysis of Oregon spotted frogs (*Rana pretiosa*) in Oregon

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INTRODUCTION

The Oregon spotted frog, *Rana pretiosa*, has experienced severe population declines and is currently listed for federal protection due to extensive range contraction and small, isolated populations. Prior phylogeographic study identified a single *R. pretiosa* clade from Oregon. Here, we used microsatellite markers to characterize fine-scale population genetic structure of Oregon spotted frogs (*Rana pretiosa*) in Oregon, specifically in the Klamath Basin. We also characterized the population structure of *R. pretiosa* from the Deschutes Basin to serve as a comparison, as Deschutes populations are less susceptible to the genetic and demographic consequences of human-mediated fragmentation. Our specific objectives were to:1. Estimate the level of genetic connectivity (gene flow) among populations of Oregon spotted frogs within and among the Klamath and Deschutes Basins; 2. Identify the number and spatial distribution of distinct populations of Oregon spotted frogs; 3. Estimate effective population sizes of Oregon spotted frog populations; and 4. Test for population declines of Oregon Spotted frog using genetic bottleneck tests.

METHODS

Sample collection

Tadpole, juvenile and adult *Rana pretiosa* frogs were sampled over 4 years, between September 2007 and September 2011 (Table 1). The final number of samples per collection site ranged from 5 – 23 in the Deschutes Basin and 1 – 27 in the Klamath (Table 1). Population genetic analyses are sensitive to sample size (requires at least 5 individuals per site), temporal and spatial sampling. To reduce statistical bias in our analyses, we evaluated the spatial sampling for each site and grouped samples from ponds located within 500 m to ensure adequate sampling sizes. The demographic and genetic signature of frog populations are dynamic and could potentially change rapidly over the course of a few years, especially for animals with a short generation time and that occur in small populations. Therefore, we determined whether sites that contained individuals sampled from multiple years were in Hardy-Weinberg

Equilibrium (HWE), and if not, we analyzed each sampling year as a separate 'site' (Table 1). For example, Jack Creek (Klamath Basin) samples were out of genetic equilibrium when samples collected from 2009 and 2010 were combined (HWE, *p*-value <0.001), but in HWE when analyzed separately (Table 1).

Laboratory Methods

Genomic DNA was extracted from either toe clips or buccal swabs using Qiagen DNEasy Kits. We amplified all individuals at 8 microsatellite loci, previously published for *R. luteinventris* and *R. pretiosa* (Monsen and Blouin 2004; Funk et al. 2005). We amplified PCR fragments in two multiplex PCR reactions using QIAGEN multiplex PCR kits. Each 10 µl multiplex PCR reaction contained 5 µl of 2x QIAGEN Multiplex PCR Master Mix (3mM $MgCl_2$), 1 µl of 5X Q-Solution, 0.2 µl of each primer (10 µM), and approximately 10 ng of genomic DNA. Multiplex 1 contained the loci RP17, RP193, SFC134, SFC139 and multiplex 2 contained the loci RP15, RP23, SFC128, RP3. The PCR conditions for both multiplex PCR were as follows: an initial denaturation of 95°C for 15 min, followed by 35 cycles of 95°C for 30 sec, 58°C for 90 sec, 72°C for 60 seconds, followed by a final extension of 60°C for 60 min. The PCR product was prepared for fragment analysis on a capillary sequencer with HIDI formamide and LIZ ladder (500 GeneScan). We scored microsatellite alleles using GeneMarker v 1.91.

Descriptive statistics

The average number of alleles per locus, observed and expected heterozygosities and conformation to Hardy-Weinberg Equilibrium (HWE) was examined using Arlequin 3.5 (Excoffier et al. 2005). We evaluated loci for linkage disequilibrium (whether alleles at different loci are non-randomly associated) using GENEPOP version 4.0.10 on the web (Raymond and Rousset 1995; Rousset 2008). We used Micro-checker 2.2.3 (van Oosterhout et al. 2006) to test for the presence of null alleles.

Demographic History

We estimated the effective population sizes using a Bayesian model implemented in OneSamp (Tallmon et al. 2008). The effective population size (*Ne*) can be thought of as the number of individuals that pass their genes on to the next generation. More specifically, the rate at which genetic diversity is lost in a population due to genetic drift is inversely related to *Ne*. Effective population size is an important parameter to consider in conservation because smaller populations are more likely to suffer from low genetic diversity and are susceptible to genetic drift and the negative consequences of inbreeding. This model requires at least 18 individuals per sampling site (Tallmon et al. 2008).

Demographic history was investigated by evaluating whether sites experienced recent genetic bottlenecks by testing for heterozygosity excess in the program BOTTLENECK 1.2 0.2 (Cornuet and Luikart 1996). Populations that undergo rapid reduction in size are expected to show an excess of heterozygosity for the observed number of alleles because the loss of rare alleles is faster than the loss of heterozygosity. We used two models, the infinite alleles model (IAM) and the two-parameter model (TPM). Following Funk et al. (2010), we examined the TPM with *a priori* parameters (variance = 12 and proportion of IAM in the model at 10 %). We tested for significance using the Wilcoxon signed rank test, a test appropriate for datasets containing fewer than 20 polymorphic loci. We also examined the shape of the allele frequency distribution: a skewed distribution indicates a bottleneck whereas a normal distribution is characteristic of

stable populations. In general, BOTTLENECK is sensitive to detecting recent bottleneck events. More specifically, BOTTLENECK detects bottlenecks that occurred within the last $2N_e$–$4N_e$ generations (Cornuet and Luikart 1996). Thus, for example, if $N_e = 20$ for a given population, then BOTTLENECK could detect a bottleneck that occurred within the last 40 generations. If generation time is 2 years, this translates to 80 years. BOTTLENECK has been shown to be the best approach for detecting recent bottlenecks of relatively low magnitude (Williamson-Natesan 2005).

Population Genetic Structure

Population genetic structure was examined using three complementary approaches: pairwise comparisons between all sites (F_{ST}), Bayesian model-based assignment tests to identify genetic clusters (STRUCTURE), and analyses of molecular variance (AMOVA) among major groups.

a) Pairwise F_{ST} is the proportion of total genetic variation due to among population differences and ranges from 0 – 1. We calculated F_{ST} for every pair of sites and tested whether it was different from zero with 500 permutations. A non-significant F_{ST} (F_{ST} is not different from 0) indicates that those two sites are not significantly divergent. Analyses were conducted in Arlequin 3.11 (Excoffier et al., 2005).

b) We performed an individual-based clustering analyses in STRUCTURE v 2.3.3 (Pritchard et al. 2000) to determine the number of genetic clusters across all sites. This is a Bayesian clustering method that assigns each individual (independent of sampling site) to a particular genetic cluster based on it's genotype across all loci. We ran the model with a range of possible genetic clusters (1 – 20). Each model was run 10 times and verified for convergence with log likelihood values. We used an initial burn-in of 100,000 with an additional 3,000,000 iterations. Correlated allele frequencies and admixture were assumed. The most likely number of genetic clusters was determined using the DeltaK method (Evanno et al. 2005) and by calculating the posterior probabilities of each model. We initially conducted analyses on all sampling sites combined. This analysis revealed two major genetic groups, the Deschutes and Klamath Basins. We subsequently ran analyses for each of basin separately, and then conducted iterative STRUCTURE runs on discrete clusters until K = 1 was supported.

c) Genetic structuring within and between the Deschutes and Klamath Basins was tested with AMOVA using pairwise F_{ST}, performed in Arlequin v3.11. We tested the level of genetic differentiation with 1023 permutations.

RESULTS

Descriptive statistics, Hardy Weinberg Equilibrium, Linkage Equilibrium

Microsatellite genotyping revealed an extremely low mean number of alleles per locus for Deschutes (mean ± STD = 2.14 ± 0.43) and Klamath sites (mean ± STD = 2.81 ± 0.65). The observed heterozygosity across all loci per site for Deschutes ranged from 0.17 – 0.45 (mean ± STD = 0.31 ± 0.015) and ranged from 0.27 – 0.67 (mean ± STD = 0.46 ± 0.019) for the Klamath Basin. Several sites were not in HWE ($p > 0.05$; Table 1). The *P* value for all loci combined is provided for each population. Pairwise comparison of all loci (combined across sites) showed no evidence of linkage, indicating that each locus evolves independently.

Demographic History

Estimates of effective population size (*Ne*) were relatively small in both basins, ranging from 12.64 – 31.21 (average ± STD = 20.78 ± 7.28; Table 1) in the Deschutes Basin and 11.5 – 27.76 (average ± STD = 18.39 ± 5.68; Table 1) in the Klamath Basin.

Bottleneck analyses using IAM, TPM and allele distribution shape revealed a loss in allelic diversity for two sites in the Deschutes Basin (CR_09_Bull, SR_NCPond) and no evidence for a bottleneck in Klamath sites for which we had sufficient sample size (Table 2). We did not conduct bottleneck tests for other sites in the study due to small samples sizes (N < 18 individuals).

Population Genetic Structure

a) Pairwise F_{ST} were high within each basin, ranging from 0 – 0.596 (average = 0.165) in the Deschutes, with 207 (75 %) significant pairwise comparisons ($p < 0.05$; Table 3). In the Klamath, pairwise F_{ST} values were higher, ranging from 0 – 0.833 (average = 0.215), with 71% significant pairwise comparisons (Table 4). As expected, within basins genetic divergence was lower than pairwise comparison of sites between basins: between basin pairwise F_{ST} ranged from 0.05 – 0.835 (average = 0.541; Table 5).

b) STRUCTURE. The clustering method implemented in STRUCTURE identified two main clusters, the Deschutes and Klamath Basins. The method implemented by Evanno *et al*. supported K = 2, and the posterior probability supported K = 10. For this range of K (2 – 10), all showed strong genetic structuring between Deschutes and Klamath, and thus were analyzed separately and discussed below (Fig. 1).

Deschutes Basin

Four groups were identified within the Deschutes basin (Fig. 2). The posterior probability method selected K = 5, while the ΔK maximum selected K = 2; however visual inspection of assignment plots best support K = 4 (referred hereafter as clusters A, B, C, D; Table 1). Cluster A contained Marsh/Mud, Muskrat Lake, Crosswater and Sunriver sites. Subsequent STRUCTURE analysis of Cluster A supported two genetic clusters (A1, A2), with only a few individuals assigned to A2 (Fig. 3; Table 1). Cluster B contained individuals from Dilman sites, with all individuals being assigned to a single genetic cluster. Hosmer Lake individuals were also assigned to cluster 'B' (Fig. 2).

Cluster C contained individuals from the Little Deschutes complex (Little Deschutes at 100 Rd and BLM Oxbow), Gold Lake Pond, Scotty Big Boy, and East Big Marsh (Fig. 2). Subsequent STRUCTURE analysis of Cluster C showed 2 sub-clusters (C1, C2), both of which occurred in all sites. One site, CAS, contained individuals assigned to each of three clusters (A, B, C), indicating either admixture or convergence of allele frequencies. Finally, two Camas sites, assigned to cluster D were genetically divergent from all other sites, showing no admixture with other clusters.

Klamath Basin

In the Klamath Basin, seven genetic clusters were identified, referred to as clusters E – K in Table 1 (Fig. 4). We conducted subsequent STRUCTURE analyses on each of these clusters. Within cluster E, we found support for two sub-clusters. Most individuals from Jameson Meadow (samples from 2009 and 2010) were assigned to cluster E1, while many individuals (81%) from the other Jack Creek sites were assigned to cluster E2 (Table 1; Fig. 5). STRUCTURE analyses revealed two sub-clusters in the Klamath Marsh complex (cluster F), with substantial admixture of those two clusters within most, but not all sites (Table 1; Fig. 5). Most Sevenmile Creek and Crane Creek samples were assigned to cluster H (Fig. 6).

However, Sevenmile Creek samples from 2009 were assigned to a genetically distinct cluster, G. Clusters H, I, and J occur in geographically isolated sites, indicating limited admixture among sites (Fig. 5).

d) We found strong support that Deschutes and Klamath are genetically divergent basins. An AMOVA showed that 39.87% of genetic variation could be explained by basin, with only 14.69% due to variation among sites (Table 6). Within the Deschutes Basin, an AMOVA of the 5 groups identified by the STRUCTURE analyses was well supported with 26.82% of genetic variation explained by genetic cluster and 6.15% of the variation due to variation among sites within each cluster. Within the Klamath Basin, an AMOVA using the 7 groups identified by STRUCTURE analyses (see Table 1) was well supported with 20.71% of genetic variation explained by genetic cluster and only 4.51% due to variation among sites within each cluster.

DISCUSSION

Rana pretiosa occur in small populations that are highly differentiated from most other sites. We used several approaches to understand the genetic relationship among sites and identify the number of distinct genetic clusters, estimate the effective population sizes, and test for recent (and/or historical) bottleneck events.

The level of genetic connectivity (gene flow) among populations and the number and spatial distribution of distinct populations

Rana pretiosa from the Deschutes and Klamath Basins are highly differentiated (Figure 1; Table 1, Table 3). Multiple lines of evidence also show substantial differentiation among sites within each group (Figures 2 – 6; Table 3). Populations in the Klamath Basin showed higher average pairwise F_{ST} values than Deschutes sites, indicating higher levels of genetic divergence (less connectivity) among Klamath Basin sites.

The high level of genetic differentiation both among basins as well as within each basin, provides substantial evidence that *R. pretiosa* sites comprise several isolated and distinct genetic groups. F_{ST} values range from zero – 1, with zero indicating ongoing gene flow (no differentiation) and 1 indicating no gene flow. For amphibians, it is generally agreed that a F_{ST} value greater than 0.3 provides evidence of very restricted gene flow. This study revealed many instances of pairwise F_{ST} values greater than 0.3. For example, Camas Prairie (Table 3a) and Parsnip (Table 4a) showed exceptionally high pairwise F_{ST} values to almost all sites (pairwise F_{ST} values > 0.5) underscoring the isolation of these sites to other *R. pretiosa* sites. In some cases, we found surprising genetic structure among geographically proximate sites. For example, almost all pairwise F_{ST} estimates among Jack Creek sites were significantly different from zero (Table 4a.; indicating restrictions in gene flow), despite that samples were taken from the same pond but in different years, or sampled within a distance less than 2 km.

We are applying landscape genetic approaches to rigorously test the role of landscape and geological features in shaping the genetic distribution of diversity among these sites. Specifically, we are applying gravity models (Murphy et al.) to test the relative importance of topography, slope position, wetland distribution, stream network, and temperature on connectivity among these sites. The strength of gravity models is the incorporation of 'at-site' and 'between-site' landscape variables in predicting the factors that

play a role in population connectivity. These analyses are time-intensive and are not completed at this time, but will be included in forthcoming publications in scientific journals.

Estimates of effective population size and tests for population declines using genetic bottleneck tests.

The consequences of population bottlenecks on frog populations include reduced population viability and persistence and reduced genetic variation (which may result in lower fitness). Overall, *R. pretiosa* sites are characterized by very small effective population sizes, low heterozygosity and low allelic richness (Table 1).

Our analyses provided some evidence of population bottlenecks for only two sites in the Deschutes Basin, and none for the Klamath. Because the analyses used to estimate a bottleneck require sample sizes > 18 individuals, we could not determine whether or not a bottleneck event occurred for small isolated populations. A prior comparative study of *Ne* within and among four pacific northwestern ranid species revealed low estimates of genetic diversity and small effective populations sizes (overall *Ne* < 50; Phillipsen et al. 2011). Estimates of *Ne* for the 11 populations of *R. pretiosa* in our analyses ranged from 11.5 – 31.21 (average = 19.69), which was within the range of *Ne* for *R. pretiosa* revealed in the Phillipsen et al (2011) study, but smaller then estimates of other ranid species.

Management implications

Oregon spotted frog populations that occur in both the Deschutes and Klamath basins are relatively small (small effective population sizes), exhibit low genetic variation, and are highly differentiated from most other sites. Klamath Basin sites show relatively higher levels of genetic differentiation among sites, indicating that genetic groups are more isolated (less connected by gene flow). The threats to small and isolated populations include susceptibility to demographic stochasticity, reductions in genetic diversity, and inbreeding effects. These threats increase the probabilities of population extirpation.

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Table 1. Sampling sites and microsatellite marker characteristics for *Rana pretiosa* in Oregon in the Deschutes and Klamath Basins. Cluster assignment indicated for each sampling site, with sub-cluster indicated by numbers (e.g., A1). For each population, the site name and abbreviation (Site Abb.) and sampling size (N), the average number of alleles per locus (No.All), number of monomorphic loci (M), and observed heterozygosity (Ho) and expected heterozygosity (He) given Hardy Weinburg Equilibrium (HWE). P-value for tests of HWE provided, with significant ($p < 0.05$) indicating departure from HWE. Effective population size (Ne) for sites containing more than 18 individuals.

Basin	Population	Site Name	Site Abb.	Cluster	HWE	No.All	Ho	He	M	Sample Date	N	Ne mean (range)
Deschutes	Camas Prairie	Camas 2007	Cam07	D	0.0001	3.00	0.23	0.46	3	2007	8	
		Camas2010	Cam10	D	0.958	1.63	0.36	0.30	4	2010	13	
	Unnamed Marsh, Mud Lake	Unnamed Marsh, Mud Lake	Marsh/Mud	A1	0.898	1.75	0.43	0.42	5	2010	7	
	Muskrat Lake	Muskrat Lake	Muskrat	A1,2	0.000	3.25	0.26	0.41	1	2007	16	
	Casey Tract North	Casey Tract North	CAS	A1,A2,B, C1,C2	0.000	2.38	0.28	0.57	3	2007	9	
	Hosmer Lake	Hosmer Lake (Hosmer)	Hosmer	B	0.000	2.00	0.26	0.57	3	2007	10	
	Crosswater (CR)	Fairway 2	CR_Fair	A1	0.501	1.75	0.40	0.50	4	2009	5	
		Lodge Oxbow, West Bay	CR_LWest	A1,2	0.018	2.50	0.30	0.35	2	2009	12	
		Lodge Oxbow, East Bay	CR_LEast	A1,2	0.000	2.38	0.23	0.50	3	2009	13	
		Bullfrog Pond 2009	CR_09_Bull	A1	0.750	1.88	0.37	0.42	4	2009	23	12.64 (8.16-22.57)
		Bullfrog Pond 2007	CR_07_Bull	A1,2	0.103	2.00	0.23	0.35	4	2009	5	
		North Driving Range	CR_NoDriv	A1	0.294	2.00	0.38	0.40	4	2007	6	
	Sunriver (SR)	Nature Center Pond	SR_NCPond	A1	0.398	2.63	0.33	0.34	2	2009	21	26.96 (18.05-45.28)

		9th Tee pond	SR_9th	A1	0.948	2.00	0.30	0.31	4	2009	19	14.96 (9.97-25.48)
		Vista 1-4	SR_Vista	A1	0.612	2.00	0.38	0.39	4	2009	21	16.75 (10.74-29.45)
		Duck Pond	SR_Duck	A1,2	0.261	2.50	0.34	0.40	2	2009	10	
		17th Fairway	SR_17thFair	A1	1.000	1.63	0.33	0.31	6	2009	6	
	Dilman	Pond 1 east & west + 7	Dilman_Pond 7	B	0.941	1.88	0.45	0.39	3	2009	11	
		Pond 6	Dilman_Pond 6	B	0.472	2.00	0.43	0.42	3	2009	10	
		Pond 5 north	Dilman_Pond 5	B	0.423	1.88	0.17	0.07	4	2009	10	
		East Excavation + South Bathtub + Mid	Dilman_EES	B	0.480	2.00	0.43	0.49	3	2009	12	
	Little Deschutes River	@100 Rd	LitDesc_100	C1,2	1.000	2.00	0.29	0.26	4	2009	20	22.16 (13.39-39.58)
		BLM Oxbow	LitDesch_BLM	C1,2	0.435	2.38	0.37	0.43	3	2009	6	
	Scotty Big Boy	Scotty Big Boy	ScottyBig	C1,2	0.864	1.63	0.26	0.30	4	2009	11	
	Gold Lake Pond	Gold Lake Pond	GoldLake	C1,2	0.203	1.88	0.20	0.34	4	2007	11	
	East Big Marsh	East Big Marsh	BigMarsh	C1,2	0.072	2.88	0.31	0.34	3	2007	23	31.21 (18.36-60.86)
Basin	Population	Site Name	Site Abb.	Cluster	HWE	No.All.	Ho	He	M	Sample Date	N	Ne mean (range)
Klamath	Parsnip Lakes	Beaver Pond, Site A and B	Parsnip	K	na	2.14	na	na	7	2009	18	
	Farris Property	Farris Ditch	Farris	I	0.793	3.00	0.46	0.53	3	2009, 2010	5	

	Jack Creek	USFS Parcel, 2010	Jack_USFS	E2	0.251	2.88	0.36	0.39	2	2009	21	16.87 (12.70-24.41)
		Jack Creek	Jack_2007	E2	0.083	2.00	0.28	0.55	3	2007	5	
		Jameson Meadow	Jack_10_Jame	E1	0.406	3.00	0.34	0.38	1	2010	12	
		Jameson Meadow	Jack_09_Jame	E1	0.087	3.00	0.33	0.38	1	2009	15	
	Klamath Marsh											
		Military Crossing	Kl_MilCros	F1,2	0.000	4.25	0.50	0.54	0	2010	23	27.26 (22.05-41.12)
		Devine	Kl_Devine	F1	0.085	3.13	0.48	0.55	1	2010	17	
		Peninsula Rd	Kl_Pen	F1	0.913	2.75	0.40	0.50	1	2010	7	
		Cholo	Cholo	F1,2	0.095	3.00	0.46	0.52	2	2010	6	
		Big Springs Kane	Kl_BigSprKane	F1,2	0.984	2.25	0.57	0.59	2	2010	4	
		Big Springs South of Gage & West Gage	Kl_SouthGage	F1,2	0.549	3.25	0.458	0.574	2	2010	7	
		Big Springs Corral & Pond	Kl_Corral	F1,2	1.000	2.75	0.52	0.49	2	2010	7	
		Big Springs Pat Kane Ditch	Kl_KaneDitch	F1,2	0.771	3.00	0.55	0.65	3	2010	4	
		Big Springs Weir & Big Springs	Kl_Weir	F1,2	0.421	2.75	0.33	0.66	2	2009, 2010	5	
		Rock Island Pond & Creek	Kl_Rock	F2	0.618	2.50	0.67	0.8	3	2010	3	
	Upper Williamson River	Rocky Ford	UWill	E,G,H,	0.201	2.50	0.40	0.69	3	2010	4	
	Seven mile Creek	Main Beaver Pond 2010	Seven10	H	0.035	3.75	0.47	0.63	1	2009	7	
		Main Beaver Pond 2009	Seve_09	G	0.122	2.75	0.29	0.67	1	2010	3	
		Middle Beaver	SevenMid	H	na	1.25	na	na	6	2010	1	

		Lowest Beaver Pond	SevenLow	H	1	2.25	0.67	0.64	4	2010	3	
	Wood River Canal	BLM Site	Wood_BLM	I	0.446	2.50	0.55	0.63	5	2009	3	
		Hawkins 1	Wood_Hawk1	I	0.721	2.88	0.41	0.44	2	2009	10	
		Hawkins 2	Wood_Hawk2	I	0.044	3.88	0.42	0.43	0	2009	12	
		Wood	Wood	I	0.000	4.13	0.36	0.47	0	2007	12	
	Buck Lake	Buck	Buck_07	J	0.380	2.75	0.51	0.47	2	2007	14	
		NW Pasture	Buck_NW	J	0.447	3.25	0.46	0.44	1	2010	22	11.50 (9.08-16.44)
		West Impoundment	Buck_West	J	0.267	3.13	0.64	0.62	3	2010	20	18.68 (14.54 - 28.62)
	Fourmile Creek	Beaver Pond & Marsh	Fourmile	I	0.922	2.38	0.53	0.52	3	2010	5	
	Dixon Road	Dixon	Dixon	I	0.648	3.50	0.67	0.59	3	2010	14	
	Crane Creek	NE Wetland em 1,2,3,4	Cr_Ne	H	1.000	2.25	0.50	0.47	4	2010	4	
		Crane Creek Mystery Frogs	Cr_mys	H	0.018	3.25	0.34	0.42	2	2007	14	
		Crane Creek Founding Frogs	Cr_Found2007	H	0.114	3.00	0.40	0.40	2	2007	27	17.64 (13.01-28.18)
		Crane Creek NO1	Cr_CRCK_N01	H	0.934	1.88	0.67	0.52	5	2010	3	
		Pond 1	Cr_Nw	H	0.371	1.63	0.27	0.45	5	2010	3	

Table 2. Test of genetic bottleneck for populations with sufficiently high sample sizes (> 18 individuals). The *p* values from the Wilcoxon-Rank sum tests (1000 replications) of heterozygosity excess under the IAM and TPM model, implemented in BOTTLENECK. Test of allele frequency distribution shape in BOTTLENECK indicate whether sites are stable or shifted (evidence of a bottleneck). We interpret these results by indicating whether there is support (no, some, or strong) for a recent bottleneck.

Site	IAM	TPM	Distribution	Bottleneck
Deschutes				
SR_NCPond	0.68	0.04	Normal	some
SR_9th	0.81	0.81	Normal	no
SR_Vista	0.97	0.31	Normal	no
CR_09_Bull	0.31	1	Shifted	some
LitDesc_100	0.95	0.09	Normal	no
Big Marsh	0.03	0.06	Normal	no
Klamath				
Jack USFS	0.12	0.32	Normal	no
Kl_MilCros	0.03	0.64	Normal	no
Cr_Found2007	0.57	0.43	Normal	no
Buck_NW	0.46	1	Normal	no
Buck_West	0.06	0.62	Normal	no
Parsnip	0.5	0.5	Normal	no

Table 3. Pairwise genetic differentiation among *Rana pretiosa* in the Deschutes Basin (a) with associated pairwise *P*-values, corrected for multiple comparisons (b). F_{ST} estimated in Arelequin, with pairs that are significantly different in bold. See Table 1 for site abbreviation.

a. Pairwise F_{ST}

		1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Marsh/Mud	.													
2	Cam07	**0.443**	.												
3	Cam10	**0.649**	**0.138**	.											
4	Hosmer	**0.337**	**0.443**	**0.625**	.										
5	Muskrat	0.067	**0.393**	**0.571**	**0.261**	.									
6	SR_Duck	**0.068**	**0.396**	**0.621**	**0.263**	0.061	.								
7	SR_NCPond	0.051	**0.452**	**0.611**	**0.294**	**0.084**	-0.043	.							
8	SR_17thFair	**0.091**	**0.521**	**0.718**	**0.422**	**0.145**	0.037	0.035	.						
9	SR_9th	**0.070**	**0.504**	**0.654**	**0.332**	**0.105**	0.016	0.003	0.059	.					
10	SR_Vista	**0.069**	**0.502**	**0.649**	**0.316**	**0.103**	0.021	0.004	**0.078**	-0.021	.				
11	CR_LWest	**0.072**	**0.389**	**0.590**	**0.201**	**0.072**	0.018	0.009	**0.136**	0.034	0.016	.			
12	CR_LEast	**0.081**	**0.447**	**0.624**	**0.233**	0.046	0.032	0.041	0.087	0.039	**0.040**	0.032	.		
13	CR_Fair	0.064	**0.420**	**0.647**	**0.229**	0.061	-0.033	-0.024	0.088	-0.006	-0.022	-0.051	0.014	.	
14	CR_NoDriv	**0.100**	**0.447**	**0.665**	**0.271**	**0.110**	-0.007	-0.004	**0.128**	0.023	0.022	0.009	0.036	-0.007	.
15	CR_07_Bull	0.057	**0.443**	**0.660**	**0.258**	0.072	0.059	0.025	**0.111**	0.018	0.012	0.006	-0.005	0.023	**0.651**
16	CR_09_Bull	**0.063**	**0.483**	**0.631**	**0.308**	**0.071**	0.028	0.020	**0.112**	0.001	-0.006	-0.002	0.029	-0.028	0.021
17	Dilman_EES	**0.180**	**0.411**	**0.597**	**0.168**	**0.198**	0.056	0.118	**0.196**	**0.166**	**0.154**	**0.090**	**0.157**	**0.064**	**0.128**
18	Dilman_Pond 7	**0.273**	**0.487**	**0.661**	**0.193**	**0.263**	**0.131**	**0.187**	**0.276**	**0.229**	**0.223**	**0.186**	**0.213**	**0.152**	**0.216**
19	Dilman_Pond 5	**0.180**	**0.423**	**0.619**	**0.253**	**0.192**	**0.100**	**0.153**	**0.175**	**0.193**	**0.186**	**0.141**	**0.170**	**0.096**	**0.201**
20	Dilman_Pond 6	**0.302**	**0.495**	**0.676**	**0.264**	**0.233**	**0.105**	**0.183**	**0.290**	**0.241**	**0.245**	**0.204**	**0.200**	**0.163**	**0.188**
21	CAS	**0.151**	**0.447**	**0.639**	**0.203**	**0.069**	0.068	**0.107**	0.157	**0.134**	**0.134**	0.091	0.005	0.052	0.102
22	LitDesch_BLM	**0.159**	**0.449**	**0.649**	**0.227**	**0.167**	0.039	**0.104**	**0.154**	**0.113**	**0.124**	**0.123**	**0.110**	**0.087**	**0.112**
23	LitDesc100	**0.310**	**0.595**	**0.723**	**0.325**	**0.282**	**0.168**	**0.197**	**0.301**	**0.192**	**0.203**	**0.239**	**0.193**	**0.216**	**0.233**
24	GoldLake	**0.510**	**0.601**	**0.755**	**0.425**	**0.362**	**0.370**	**0.381**	**0.535**	**0.412**	**0.421**	**0.430**	**0.360**	**0.461**	**0.521**
25	ScottyBig	**0.483**	**0.589**	**0.746**	**0.378**	**0.322**	**0.393**	**0.409**	**0.531**	**0.449**	**0.454**	**0.436**	**0.375**	**0.451**	**0.502**
26	BigMarsh	**0.192**	**0.539**	**0.682**	**0.347**	**0.212**	**0.090**	**0.121**	**0.128**	**0.138**	**0.149**	**0.190**	**0.135**	**0.130**	**0.192**

a. Pairwise F_{ST} continued.

		15	16	17	18	19	20	21	22	23	24	25	26
15	CR_07_Bull	.											
16	CR_09_Bull	0.006	.										
17	Dilman_EES	**0.189**	**0.164**	.									
18	Dilman_Pond 7	**0.290**	**0.250**	-0.009	.								
19	Dilman_Pond 5	**0.224**	**0.192**	0.001	0.045	.							
20	Dilman_Pond 6	**0.308**	**0.255**	0.063	**0.049**	**0.126**	.						
21	CAS	0.101	**0.110**	**0.148**	**0.189**	**0.153**	**0.150**	.					
22	LitDesch_BLM	**0.180**	**0.150**	0.040	0.027	0.066	0.064	**0.110**	.				
23	LitDesc100	**0.325**	**0.237**	**0.143**	**0.095**	**0.204**	**0.122**	**0.190**	0.006	.			
24	GoldLake	**0.574**	**0.432**	**0.240**	**0.181**	**0.224**	**0.217**	**0.317**	**0.163**	**0.210**	.		
25	ScottyBig	**0.543**	**0.445**	**0.288**	**0.259**	**0.294**	**0.257**	**0.301**	**0.219**	**0.289**	**0.163**	.	
26	BigMarsh	**0.249**	**0.179**	**0.101**	**0.090**	**0.096**	**0.126**	**0.126**	-0.008	**0.049**	**0.182**	**0.282**	.

b. Pairwise *P*-values

		1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Marsh/Mud	*													
2	Cam07	0.000	*												
3	Cam10	0.000	0.000	*											
4	Hosmer	0.000	0.000	0.000	*										
5	Muskrat	0.081	0.000	0.000	0.000	*									
6	SR_Duck	0.036	0.000	0.000	0.000	0.072	*								
7	SR_NCPond	0.054	0.000	0.000	0.000	0.000	0.982	*							
8	SR_17thFair	0.036	0.000	0.000	0.000	0.000	0.189	0.144	*						
9	SR_9th	0.045	0.000	0.000	0.000	0.000	0.180	0.342	0.117	*					
10	SR_Vista	0.036	0.000	0.000	0.000	0.000	0.171	0.378	0.018	0.982	*				
11	CR_LWest	0.036	0.000	0.000	0.000	0.000	0.261	0.279	0.009	0.063	0.153	*			
12	CR_LEast	0.027	0.000	0.000	0.000	0.072	0.198	0.063	0.081	0.117	0.036	0.216	*		
13	CR_Fair	0.153	0.000	0.000	0.000	0.126	0.793	0.811	0.090	0.523	0.748	0.928	0.541	*	
14	CR_NoDriv	0.027	0.000	0.000	0.018	0.027	0.595	0.523	0.027	0.207	0.198	0.378	0.288	0.477	*
15	CR_07_Bull	0.135	0.000	0.000	0.009	0.135	0.189	0.153	0.018	0.378	0.315	0.342	0.532	0.514	0.423
16	CR_09_Bull	0.027	0.000	0.000	0.000	0.000	0.135	0.144	0.027	0.405	0.586	0.459	0.162	0.784	0.315
17	Dilman_EES	0.000	0.000	0.000	0.000	0.000	0.054	0.000	0.000	0.000	0.000	0.000	0.000	0.144	0.009
18	Dilman_Pond 7	0.000	0.000	0.000	0.000	0.000	0.009	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
19	Dilman_Pond 5	0.000	0.000	0.000	0.000	0.000	0.018	0.000	0.000	0.000	0.000	0.000	0.000	0.054	0.009
20	Dilman_Pond 6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
21	CAS	0.009	0.000	0.000	0.009	0.036	0.099	0.000	0.063	0.000	0.000	0.072	0.459	0.306	0.081
22	LitDesch_BLM	0.009	0.000	0.000	0.000	0.000	0.189	0.000	0.000	0.027	0.000	0.009	0.054	0.036	0.045
23	LitDesc100	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
24	GoldLake	0.000	0.000	0.000	0.009	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.009	0.000
25	ScottyBig	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
26	BigMarsh	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.018	0.000	0.000	0.000	0.000	0.009	0.000

Table 3b. Pairwise *P*-values continued.

		15	16	17	18	19	20	21	22	23	24	25
15	CR_07_Bull	*										
16	CR_09_Bull	0.496	*									
17	Dilman_EES	0.000	0.000	*								
18	Dilman_Pond 7	0.000	0.000	0.477	*							
19	Dilman_Pond 5	0.000	0.000	0.459	0.072	*						
20	Dilman_Pond 6	0.000	0.000	0.054	0.027	0.000	*					
21	CAS	0.153	0.000	0.000	0.000	0.000	0.000	*				
22	LitDesch_BLM	0.009	0.009	0.162	0.126	0.072	0.063	0.036	*			
23	LitDesc100	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.297	*		
24	GoldLake	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	*	
25	ScottyBig	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	*
26	BigMarsh	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.640	0.000	0.000	0.000

Table 4. Pairwise genetic differentiation among *Rana pretiosa* in the Klamath Basin (site # 25 – 60) (a) with associated pairwise *P*-values, corrected for multiple comparisons (b). F_{ST} estimated in Arelequin, with pairs that are significantly different in bold. See Table 1 for site abbreviation.

a. Pairwise F_{ST}

		25	26	27	28	29	30	31	32	33
25	Jack_USFS	.								
26	Jack_2007	**0.086**	.							
27	Jack_09_Jame	**0.118**	**0.054**	.						
28	Jack_10_Jame	**0.075**	0.056	-0.00	.					
29	Kl_BigSprKane	**0.312**	**0.316**	**0.292**	**0.304**	.				
30	Kl_Corrall	**0.291**	**0.292**	**0.282**	**0.288**	**0.125**	.			
31	Kl_SouthGage	**0.191**	**0.207**	**0.178**	**0.181**	**0.125**	**0.164**	.		
32	Kl_KaneDitch	**0.176**	**0.220**	**0.191**	**0.187**	**0.141**	-0.02	0.085	.	
33	Kl_Weir	**0.252**	**0.263**	**0.270**	**0.250**	0.104	**0.127**	0.070	**0.052**	.
34	Kl_BigSprings	**0.379**	**0.388**	**0.309**	**0.336**	**0.208**	**-0.02**	0.257	**0.016**	0.136
35	Kl_Devine	**0.227**	**0.222**	**0.231**	**0.227**	**0.114**	**0.112**	-0.02	**0.035**	0.047
36	Kl_MilCros	**0.215**	**0.204**	**0.203**	**0.210**	**0.064**	**0.102**	-0.03	**0.026**	0.041
37	Kl_Pen	**0.251**	**0.242**	**0.229**	**0.254**	**0.179**	**0.116**	0.069	**0.047**	0.181
38	Kl_Rock	**0.273**	**0.299**	**0.325**	**0.311**	**0.333**	**0.191**	**0.120**	**0.080**	0.132
39	Kl_Cholo	**0.258**	**0.291**	**0.268**	**0.255**	**0.094**	**0.116**	0.037	**-0.024**	0.050
40	UWill	**0.269**	**0.348**	**0.300**	**0.306**	**0.203**	**0.210**	**0.139**	**0.149**	0.053
42	Seven10	**0.223**	**0.277**	**0.321**	**0.282**	**0.129**	**0.149**	**0.155**	**0.069**	0.047
44	SevenLow	**0.281**	**0.382**	**0.385**	**0.344**	**0.221**	**0.141**	**0.265**	**0.068**	0.110
45	Cr_CRCK_N01	**0.317**	**0.441**	**0.405**	**0.368**	**0.302**	**0.248**	**0.266**	**0.134**	0.095
46	Cr_Found2007	**0.374**	**0.510**	**0.457**	**0.426**	**0.353**	**0.332**	**0.347**	**0.221**	**0.209**
47	Cr_mys	**0.334**	**0.469**	**0.423**	**0.394**	**0.305**	**0.304**	**0.293**	**0.214**	**0.166**
48	Cr_Ne	**0.295**	**0.426**	**0.402**	**0.361**	**0.265**	**0.293**	**0.269**	**0.202**	0.104
49	Cr_Nw	**0.369**	**0.487**	**0.442**	**0.415**	**0.348**	**0.358**	**0.291**	**0.249**	0.138
50	Fourmile	**0.274**	**0.378**	**0.338**	**0.305**	**0.216**	**0.131**	**0.223**	**0.045**	0.087
51	Dixon	**0.305**	**0.398**	**0.350**	**0.318**	**0.195**	**0.178**	**0.234**	**0.098**	**0.098**
52	Farris	**0.264**	**0.331**	**0.300**	**0.284**	0.069	**0.134**	**0.150**	**0.065**	0.020
53	Wood_Hawk2	**0.279**	**0.356**	**0.323**	**0.305**	**0.137**	**0.180**	**0.181**	**0.095**	0.051
54	Wood_Hawk1	**0.305**	**0.374**	**0.329**	**0.320**	**0.155**	**0.191**	**0.195**	**0.100**	0.077
55	Wood	**0.264**	**0.322**	**0.315**	**0.287**	**0.143**	**0.110**	**0.168**	**0.007**	0.043
56	Wood_BLM	**0.196**	0.259	**0.260**	**0.212**	0.137	-0.03	0.050	-0.15	-0.03
57	Buck_NW	**0.272**	**0.370**	**0.308**	**0.287**	**0.204**	**0.242**	**0.166**	**0.143**	**0.084**
58	Buck_West	**0.282**	**0.384**	**0.316**	**0.295**	**0.185**	**0.222**	**0.179**	**0.131**	**0.097**
59	BUCK07	**0.313**	**0.424**	**0.358**	**0.342**	**0.244**	**0.272**	**0.207**	**0.179**	**0.123**
60	Parsnip	**0.490**	**0.669**	**0.590**	**0.569**	**0.553**	**0.556**	**0.564**	**0.518**	**0.535**

Table 4a. Pairwise F_{ST} continued.

		34	35	36	37	38	39	40	42	44	45	46
25	Jack_USFS											
26	Jack_2007											
27	Jack_09_Jame											
28	Jack_10_Jame											
29	Kl_BigSprKane											
30	Kl_Corrall											
31	Kl_SouthGage											
32	Kl_KaneDitch											
33	Kl_Weir											
34	Kl_BigSprings	.										
35	Kl_Devine	0.259	**.**									
36	Kl_MilCros	0.187	-0.005	**.**								
37	Kl_Pen	0.233	**0.082**	**0.058**	**.**							
38	Kl_Rock	0.374	0.055	**0.094**	**0.173**	**.**						
39	Kl_Cholo	0.191	**0.061**	**0.062**	**0.144**	**0.129**	**.**					
40	UWill	0.380	0.064	**0.085**	**0.260**	0.126	**0.123**	**.**				
42	Seven10	0.206	**0.178**	**0.175**	**0.264**	**0.225**	**0.123**	**0.162**	**.**			
44	SevenLow	0.168	**0.250**	**0.222**	**0.347**	0.319	**0.192**	0.244	0.044	**.**		
45	Cr_CRCK_N01	0.327	**0.249**	**0.232**	**0.390**	0.329	**0.185**	0.207	0.079	-0.01	**.**	
46	Cr_Found2007	**0.399**	**0.321**	**0.304**	**0.468**	**0.407**	**0.281**	**0.242**	**0.171**	0.032	-0.027	**.**
47	Cr_mys	0.409	**0.262**	**0.261**	**0.426**	**0.349**	**0.246**	**0.146**	**0.122**	0.092	0.007	0.023
48	Cr_Ne	0.383	**0.247**	**0.230**	**0.397**	**0.345**	**0.197**	**0.179**	0.045	0.033	-0.05	0.012
49	Cr_Nw	0.494	**0.268**	**0.247**	**0.440**	0.386	**0.211**	0.235	0.163	0.212	-0.01	**0.122**
50	Fourmile	0.143	**0.224**	**0.192**	**0.308**	**0.298**	**0.163**	**0.193**	0.067	-0.07	-0.01	0.046
51	Dixon	0.185	**0.222**	**0.214**	**0.335**	**0.304**	**0.142**	**0.163**	**0.079**	0.016	-0.021	**0.056**
52	Farris	0.142	**0.152**	**0.123**	**0.262**	**0.264**	0.049	0.120	0.030	0.051	0.04	**0.119**
53	Wood_Hawk2	0.200	**0.175**	**0.159**	**0.298**	**0.275**	**0.118**	**0.092**	**0.065**	0.059	0.035	**0.095**
54	Wood_Hawk1	0.189	**0.192**	**0.164**	**0.305**	**0.301**	**0.130**	**0.116**	**0.109**	0.072	0.071	**0.111**
55	Wood	0.082	**0.186**	**0.170**	**0.258**	**0.237**	**0.119**	**0.139**	0.030	-0.02	-0.00	**0.076**
56	Wood_BLM	0.074	**0.132**	**0.090**	**0.162**	0.092	0.084	0.183	0.002	0.006	0.068	**0.161**
57	Buck_NW	**0.256**	**0.191**	**0.179**	**0.303**	**0.277**	**0.170**	**0.104**	**0.128**	**0.124**	0.048	**0.111**
58	Buck_West	**0.226**	**0.212**	**0.194**	**0.314**	**0.308**	**0.174**	**0.121**	**0.116**	**0.084**	0.035	**0.097**
59	BUCK07	0.323	**0.228**	**0.213**	**0.365**	**0.331**	**0.214**	**0.102**	**0.138**	**0.125**	0.050	**0.093**
60	Parsnip	**0.729**	**0.492**	**0.443**	**0.609**	**0.692**	**0.488**	**0.635**	**0.372**	**0.476**	**0.517**	**0.392**

Table 4a. Pairwise F_{ST} continued.

		47	48	49	50	51	52	53	54	55	56	57	58	59
47	Cr_mys	.												
48	Cr_Ne	-0.00	.											
49	Cr_Nw	0.112	0.018	.										
50	Fourmile	**0.078**	0.049	**0.198**	.									
51	Dixon	**0.062**	0.010	**0.102**	-0.00	.								
52	Farris	**0.102**	0.035	0.131	0.022	-0.00	.							
53	Wood_Hawk2	**0.058**	0.017	0.089	0.038	0.029	-0.01	.						
54	Wood_Hawk1	**0.090**	0.071	**0.126**	0.047	0.065	0.011	-0.01	.					
55	Wood	**0.079**	0.033	0.093	-0.01	0.025	0.008	0.019	0.016	.				
56	Wood_BLM	**0.138**	0.103	0.219	0.013	0.031	0.020	0.057	0.084	-0.02	.			
57	Buck_NW	**0.079**	**0.053**	**0.102**	**0.048**	**0.069**	0.045	**0.059**	**0.077**	**0.079**	0.065	.		
58	Buck_West	**0.082**	**0.049**	**0.128**	0.019	**0.041**	0.032	**0.056**	**0.076**	**0.063**	**0.077**	0.006	.	
59	BUCK07	**0.046**	**0.076**	**0.142**	**0.064**	**0.084**	**0.078**	**0.049**	**0.056**	**0.076**	**0.142**	**0.029**	0.023	.
60	Parsnip	**0.460**	**0.469**	**0.641**	**0.427**	**0.333**	**0.402**	**0.427**	**0.489**	**0.368**	**0.481**	**0.375**	**0.347**	**0.475**

Table 4b. Pairwise *P*-values.

		25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	44	45	46
25	Jack_USFS	.																				
26	Jack_2007	0.026	.																			
27	Jack_09_Jame	0.000	0.079	.																		
28	Jack_10_Jame	0.000	0.111	0.413	.																	
29	Kl_BigSprKane	0.000	0.004	0.000	0.000	.																
30	Kl_Corrall	0.000	0.002	0.000	0.000	0.003	.															
31	Kl_SouthGage	0.000	0.001	0.000	0.000	0.020	0.001	.														
32	Kl_KaneDitch	0.000	0.009	0.000	0.000	0.038	0.534	0.060	.													
33	Kl_Weir	0.002	0.021	0.000	0.003	0.164	0.007	0.153	0.413	.												
34	Kl_BigSprings	0.999	0.999	0.999	0.999	0.999	0.999	0.999	0.999	0.999	.											
35	Kl_Devine	0.000	0.000	0.000	0.000	0.004	0.000	0.836	0.123	0.158	0.068	.										
36	Kl_MilCros	0.000	0.000	0.000	0.000	0.022	0.000	0.950	0.162	0.131	0.128	0.607	.									
37	Kl_Pen	0.000	0.001	0.000	0.000	0.006	0.004	0.082	0.168	0.020	0.115	0.000	0.005	.								
38	Kl_Rock	0.001	0.020	0.000	0.000	0.023	0.002	0.030	0.155	0.095	0.235	0.103	0.009	0.012	.							
39	Kl_Cholo	0.000	0.002	0.000	0.000	0.008	0.006	0.160	0.633	0.165	0.289	0.020	0.007	0.002	0.005	.						
40	UWill	0.000	0.006	0.001	0.000	0.035	0.002	0.004	0.116	0.615	0.188	0.058	0.014	0.002	0.123	0.011	.					
41	Seve_09	0.000	0.009	0.001	0.001	0.036	0.011	0.013	0.063	0.104	0.265	0.000	0.001	0.005	0.112	0.020	0.031	.				
42	Seven10	0.000	0.001	0.000	0.000	0.027	0.002	0.000	0.116	0.386	0.375	0.000	0.000	0.000	0.010	0.002	0.020	0.012	.			
44	SevenLow	0.002	0.016	0.001	0.000	0.018	0.010	0.011	0.031	0.211	0.212	0.000	0.000	0.011	0.094	0.015	0.050	0.104	0.280	.		
45	Cr_CRCK_N01	0.000	0.028	0.002	0.003	0.031	0.015	0.009	0.017	0.318	0.252	0.001	0.000	0.008	0.094	0.007	0.053	0.096	0.147	0.297	.	
46	Cr_Found2007	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.005	0.050	0.000	0.000	0.000	0.001	0.000	0.001	0.001	0.000	0.188	0.688	.
47	Cr_mys	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.020	0.070	0.000	0.000	0.000	0.001	0.000	0.014	0.003	0.006	0.058	0.385	0.073
48	Cr_Ne	0.000	0.008	0.000	0.000	0.021	0.003	0.003	0.031	0.058	0.192	0.000	0.000	0.004	0.018	0.008	0.033	0.034	0.261	0.141	0.794	0.281
49	Cr_Nw	0.001	0.025	0.000	0.002	0.026	0.006	0.010	0.032	0.303	0.256	0.000	0.001	0.006	0.108	0.011	0.097	0.097	0.054	0.110	0.906	0.030
50	Fourmile	0.000	0.008	0.000	0.000	0.008	0.003	0.002	0.014	0.084	0.364	0.000	0.000	0.002	0.016	0.004	0.008	0.024	0.072	0.765	0.280	0.070
51	Dixon	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.002	0.028	0.132	0.000	0.000	0.000	0.001	0.000	0.001	0.001	0.004	0.232	0.589	0.001
52	Farris	0.000	0.005	0.000	0.000	0.159	0.003	0.007	0.088	0.499	0.323	0.000	0.000	0.002	0.012	0.104	0.061	0.019	0.385	0.241	0.291	0.002
53	Wood_Hawk2	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.015	0.179	0.167	0.000	0.000	0.000	0.003	0.000	0.025	0.003	0.027	0.076	0.153	0.000
54	Wood_Hawk1	0.000	0.000	0.000	0.000	0.008	0.000	0.000	0.030	0.124	0.187	0.000	0.000	0.000	0.002	0.001	0.023	0.002	0.006	0.092	0.095	0.000
55	Wood	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.531	0.278	0.303	0.000	0.000	0.000	0.002	0.000	0.006	0.001	0.210	0.818	0.622	0.000
56	Wood_BLM	0.005	0.072	0.001	0.004	0.102	0.659	0.220	0.909	0.823	0.498	0.012	0.027	0.045	0.305	0.120	0.056	0.209	0.632	0.671	0.391	0.004
57	Buck_NW	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.040	0.040	0.000	0.000	0.000	0.000	0.000	0.003	0.000	0.000	0.005	0.086	0.000
58	Buck_West	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.022	0.049	0.000	0.000	0.000	0.000	0.000	0.001	0.002	0.001	0.025	0.136	0.000
59	BUCK07	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.003	0.022	0.065	0.000	0.000	0.000	0.004	0.000	0.016	0.002	0.000	0.013	0.117	0.000
60	Parsnip	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.049	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000

Table 4b. Pairwise *P*-values.

		47	48	49	50	51	52	53	54	55	56	57	58	59
47	Cr_mys	.												
48	Cr_Ne	0.465	.											
49	Cr_Nw	0.059	0.589	.										
50	Fourmile	0.040	0.055	0.019	.									
51	Dixon	0.003	0.257	0.045	0.377	.								
52	Farris	0.011	0.293	0.129	0.335	0.547	.							
53	Wood_Hawk2	0.003	0.238	0.058	0.101	0.035	0.772	.						
54	Wood_Hawk1	0.001	0.063	0.041	0.078	0.002	0.382	0.855	.					
55	Wood	0.001	0.224	0.117	0.716	0.057	0.530	0.200	0.282	.				
56	Wood_BLM	0.034	0.124	0.192	0.354	0.153	0.414	0.141	0.105	0.790	.			
57	Buck_NW	0.000	0.049	0.017	0.045	0.000	0.063	0.000	0.001	0.000	0.067	.		
58	Buck_West	0.000	0.045	0.002	0.169	0.005	0.123	0.000	0.000	0.001	0.041	0.235	.	
59	BUCK07	0.015	0.025	0.016	0.042	0.000	0.023	0.001	0.016	0.001	0.019	0.027	0.044	.
60	Parsnip	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Table 5. Pairwise genetic differentiation among *Rana pretiosa* sites in the Deschutes and Klamath Basins (a) with associated pairwise *P*-values (b). F_{ST} estimated in Arelequin, with pairs that are significantly different in bold. See Table 1 for site abbreviation. Deschutes sites are listed 1-23 (see Table 3), and Klamath sites are listed 25-60.

Table 5a. Pairwise F_{ST}

		DESCHUTES									
		1	2	3	4	5	6	7	8	9	10
KLAMATH		Cam07	Cam10	Hosmer	Muskrat	SR_Duck	SR_NCPond	SR_17thFair	SR_9th	SR_Vista	Cr_LWest
Jack_USFS	26	0.441	0.595	0.546	0.509	0.463	0.532	0.569	0.588	0.587	0.500
Jack_2007	27	0.443	0.658	0.590	0.542	0.522	0.573	0.634	0.643	0.644	0.550
Jack_09_Jame	28	0.419	0.604	0.564	0.521	0.480	0.546	0.596	0.606	0.605	0.517
Jack_10_Jame	29	0.426	0.616	0.546	0.500	0.457	0.530	0.581	0.594	0.593	0.498
Kl_BigSprKane	30	0.348	0.604	0.566	0.512	0.487	0.547	0.621	0.623	0.624	0.521
Kl_Corrall	31	0.384	0.606	0.526	0.478	0.426	0.506	0.564	0.579	0.583	0.475
Kl_SouthGage	32	0.287	0.533	0.453	0.400	0.324	0.436	0.496	0.511	0.515	0.391
Kl_KaneDitch	33	0.349	0.614	0.461	0.401	0.325	0.435	0.525	0.523	0.529	0.394
Kl_Weir	34	0.295	0.575	0.507	0.455	0.405	0.492	0.553	0.572	0.574	0.454
Kl_Devine	35	0.299	0.498	0.481	0.444	0.392	0.475	0.508	0.531	0.532	0.437
Kl_MilCros	36	0.265	0.448	0.453	0.423	0.361	0.451	0.476	0.503	0.504	0.411
Kl_Pen	37	0.375	0.595	0.547	0.498	0.464	0.528	0.588	0.599	0.601	0.502
Kl_Rock	38	0.400	0.667	0.542	0.483	0.450	0.518	0.607	0.600	0.602	0.492
Kl_Cholo	39	0.357	0.597	0.504	0.456	0.407	0.496	0.548	0.568	0.570	0.452
UWill	40	0.350	0.625	0.580	0.519	0.500	0.553	0.646	0.630	0.629	0.528
Seve_09	41	0.277	0.539	0.237	0.118	0.050	0.104	0.219	0.163	0.156	0.050
Seven10	42	0.375	0.592	0.491	0.446	0.382	0.473	0.510	0.548	0.549	0.431
SevenMid	43	0.571	0.801	0.644	0.511	0.556	0.564	0.728	0.652	0.652	0.567
SevenLow	44	0.467	0.699	0.601	0.531	0.522	0.566	0.655	0.646	0.646	0.548
CR_CRCK_N01	45	0.478	0.719	0.614	0.550	0.544	0.582	0.689	0.660	0.659	0.563
CR_Found2007	46	0.529	0.675	0.618	0.570	0.537	0.588	0.649	0.641	0.639	0.569
CR_mys	47	0.477	0.657	0.600	0.552	0.521	0.575	0.638	0.636	0.635	0.551
CR_Ne	48	0.462	0.696	0.603	0.536	0.526	0.570	0.660	0.647	0.646	0.550
CR_Nw	49	0.470	0.715	0.630	0.566	0.570	0.599	0.711	0.673	0.672	0.584
Fourmile	50	0.442	0.674	0.585	0.524	0.508	0.555	0.641	0.632	0.632	0.533
Dixon	51	0.439	0.625	0.548	0.498	0.452	0.526	0.580	0.588	0.588	0.493
Farris	52	0.379	0.625	0.554	0.501	0.467	0.535	0.603	0.611	0.611	0.501
Wood_Hawk2	53	0.365	0.570	0.538	0.496	0.447	0.523	0.568	0.586	0.586	0.487
Wood_Hawk1	54	0.375	0.587	0.556	0.511	0.469	0.538	0.591	0.604	0.604	0.506
Wood	55	0.373	0.570	0.497	0.461	0.394	0.482	0.517	0.548	0.550	0.443
Wood_BLM	56	0.324	0.618	0.408	0.376	0.334	0.400	0.513	0.497	0.498	0.372
Buck_NW	57	0.365	0.547	0.505	0.466	0.409	0.487	0.534	0.545	0.543	0.447
Buck_West	58	0.409	0.587	0.538	0.492	0.436	0.511	0.561	0.572	0.570	0.478
Buck_07	59	0.427	0.618	0.574	0.527	0.479	0.544	0.604	0.609	0.607	0.515
Parsnip	60	0.719	0.826	0.757	0.694	0.711	0.703	0.813	0.760	0.755	0.716
Marsh/Mud	61	0.443	0.649	0.340	0.070	0.071	0.051	0.091	0.070	0.069	0.075

Table 5a. Continued. Pairwise F_{ST}

		DESCHUTES								
		11	12	13	14	15	16	17	18	
KLAMATH		Cr_LEast	Cr_Fair	Cr_NoDriv	Cr_07_Bull	Cr_09_Bull	Dilman_EES	Dilman_Pond 7	Dilman_Pond 6	Dilma
Jack_USFS	26	0.553	0.495	0.520	0.563	0.574	0.489	0.533	0.500	
Jack_2007	27	0.601	0.536	0.585	0.617	0.628	0.511	0.574	0.525	
Jack_09_Jame	28	0.571	0.516	0.545	0.588	0.590	0.498	0.549	0.512	
Jack_10_Jame	29	0.555	0.496	0.528	0.571	0.578	0.476	0.531	0.489	
Kl_BigSprKane	30	0.578	0.510	0.562	0.602	0.607	0.477	0.548	0.493	
Kl_Corrall	31	0.538	0.467	0.508	0.554	0.569	0.445	0.509	0.459	
Kl_SouthGage	32	0.463	0.391	0.426	0.478	0.501	0.367	0.436	0.380	
Kl_KaneDitch	33	0.476	0.393	0.454	0.508	0.513	0.357	0.440	0.375	
Kl_Weir	34	0.522	0.435	0.491	0.534	0.557	0.416	0.489	0.430	
Kl_Devine	35	0.495	0.430	0.460	0.499	0.521	0.424	0.470	0.432	
Kl_MilCros	36	0.467	0.407	0.427	0.467	0.493	0.404	0.445	0.411	
Kl_Pen	37	0.558	0.496	0.538	0.575	0.586	0.468	0.531	0.483	
Kl_Rock	38	0.555	0.485	0.549	0.588	0.585	0.443	0.522	0.460	
Kl_Cholo	39	0.524	0.426	0.486	0.531	0.552	0.427	0.490	0.437	
UWill	40	0.588	0.528	0.585	0.630	0.609	0.483	0.559	0.502	
Seve_09	41	0.152	0.063	0.105	0.100	0.135	0.136	0.242	0.162	
Seven10	42	0.499	0.404	0.443	0.496	0.533	0.410	0.471	0.424	
SevenMid	43	0.599	0.567	0.653	0.715	0.623	0.512	0.605	0.534	
SevenLow	44	0.602	0.532	0.599	0.641	0.626	0.503	0.578	0.521	
CR_CRCK_N01	45	0.622	0.562	0.633	0.676	0.639	0.514	0.592	0.534	
CR_Found2007	46	0.617	0.580	0.603	0.647	0.624	0.557	0.603	0.572	
CR_mys	47	0.605	0.556	0.586	0.633	0.619	0.530	0.584	0.546	
CR_Ne	48	0.604	0.543	0.602	0.646	0.625	0.507	0.580	0.526	
CR_Nw	49	0.638	0.588	0.660	0.697	0.653	0.534	0.609	0.553	
Fourmile	50	0.592	0.528	0.587	0.630	0.613	0.492	0.564	0.511	
Dixon	51	0.553	0.488	0.523	0.574	0.572	0.478	0.532	0.491	
Farris	52	0.566	0.483	0.542	0.588	0.591	0.467	0.535	0.482	
Wood_Hawk2	53	0.548	0.477	0.513	0.559	0.571	0.469	0.522	0.482	
Wood_Hawk1	54	0.566	0.496	0.537	0.582	0.588	0.483	0.540	0.498	
Wood	55	0.508	0.426	0.458	0.509	0.536	0.428	0.481	0.442	
Wood_BLM	56	0.448	0.360	0.439	0.492	0.480	0.303	0.384	0.343	
Buck_NW	57	0.509	0.446	0.479	0.529	0.527	0.439	0.489	0.451	
Buck_West	58	0.537	0.478	0.503	0.558	0.554	0.468	0.519	0.483	
Buck_07	59	0.575	0.519	0.545	0.599	0.591	0.498	0.554	0.517	
Parsnip	60	0.749	0.758	0.781	0.812	0.738	0.686	0.739	0.710	
Marsh/Mud	61	0.071	0.064	0.099	0.046	0.063	0.180	0.273	0.180	

Table 5a. Continued. Pairwise F_{ST}

		DESCHUTES				
		21	22	23	24	25
KLAMATH		LitDesch_BLM	LitDesc100	GoldLake	ScottyBig	BigMarsh
Jack_USFS	26	0.524	0.618	0.598	0.580	0.575
Jack_2007	27	0.550	0.693	0.702	0.664	0.636
Jack_09_Jame	28	0.539	0.643	0.621	0.609	0.595
Jack_10_Jame	29	0.516	0.635	0.623	0.598	0.582
Kl_BigSprKane	30	0.517	0.679	0.702	0.651	0.613
Kl_Corrall	31	0.476	0.624	0.641	0.581	0.565
Kl_SouthGage	32	0.400	0.569	0.585	0.518	0.496
Kl_KaneDitch	33	0.397	0.587	0.653	0.540	0.506
Kl_Weir	34	0.449	0.627	0.647	0.585	0.557
Kl_Devine	35	0.447	0.565	0.532	0.520	0.516
Kl_MilCros	36	0.423	0.531	0.486	0.485	0.487
Kl_Pen	37	0.505	0.645	0.643	0.610	0.587
Kl_Rock	38	0.488	0.658	0.719	0.631	0.587
Kl_Cholo	39	0.458	0.622	0.622	0.574	0.563
UWill	40	0.537	0.688	0.725	0.668	0.621
Seve_09	41	0.152	0.371	0.505	0.467	0.288
Seven10	42	0.437	0.598	0.601	0.556	0.538
SevenMid	43	0.560	0.728	0.834	0.744	0.656
SevenLow	44	0.545	0.701	0.749	0.682	0.637
CR_CRCK_N01	45	0.569	0.716	0.778	0.704	0.652
CR_Found2007	46	0.596	0.671	0.676	0.648	0.626
CR_mys	47	0.575	0.674	0.685	0.647	0.624
CR_Ne	48	0.558	0.702	0.748	0.685	0.638
CR_Nw	49	0.588	0.731	0.794	0.723	0.668
Fourmile	50	0.542	0.682	0.716	0.660	0.620
Dixon	51	0.514	0.627	0.624	0.590	0.577
Farris	52	0.509	0.664	0.680	0.630	0.603
Wood_Hawk2	53	0.502	0.626	0.617	0.587	0.575
Wood_Hawk1	54	0.520	0.647	0.644	0.612	0.594
Wood	55	0.455	0.587	0.580	0.547	0.535
Wood_BLM	56	0.348	0.539	0.597	0.521	0.464
Buck_NW	57	0.481	0.577	0.565	0.547	0.525
Buck_West	58	0.507	0.606	0.595	0.575	0.556
Buck_07	59	0.542	0.648	0.655	0.624	0.595
Parsnip	60	0.750	0.794	0.835	0.802	0.747
Marsh/Mud	61	0.159	0.310	0.510	0.483	0.192

Table 5b. Pairwise *P* values.

		DESCHUTES									
		Cam07	Cam10	Hosmer	Muskrat	SR_Duck	SR_NCPond	SR_17thFair	SR_9th	SR_Vista	Cr_LWest
		1	2	3	4	5	6	7	8	9	10
Jack_USFS	26	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Jack_2007	27	0.002	0.000	0.001	0.001	0.000	0.000	0.001	0.000	0.000	0.000
Jack_09_Jame	28	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Jack_10_Jame	29	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Kl_BigSprKane	30	0.004	0.000	0.001	0.000	0.000	0.000	0.002	0.000	0.000	0.001
Kl_Corrall	31	0.000	0.000	0.000	0.000	0.001	0.000	0.001	0.000	0.000	0.000
Kl_SouthGage	32	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Kl_KaneDitch	33	0.003	0.001	0.003	0.000	0.000	0.000	0.011	0.000	0.000	0.000
Kl_Weir	34	0.010	0.001	0.002	0.000	0.000	0.000	0.004	0.000	0.000	0.000
Kl_Devine	35	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Kl_MilCros	36	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Kl_Pen	37	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000
Kl_Rock	38	0.004	0.003	0.006	0.001	0.011	0.001	0.015	0.000	0.000	0.006
Kl_Cholo	39	0.000	0.000	0.001	0.000	0.000	0.000	0.003	0.000	0.000	0.000
UWill	40	0.003	0.000	0.002	0.000	0.004	0.000	0.007	0.000	0.000	0.001
Seve_09	41	0.037	0.001	0.030	0.080	0.344	0.096	0.030	0.070	0.106	0.313
Seven10	42	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000
SevenMid	43	0.999	0.999	0.999	0.999	0.999	0.999	0.999	0.999	0.999	0.999
SevenLow	44	0.006	0.001	0.001	0.002	0.008	0.000	0.015	0.000	0.000	0.004
CR_CRCK_N01	45	0.004	0.001	0.002	0.001	0.003	0.002	0.011	0.001	0.000	0.004
CR_Found2007	46	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
CR_mys	47	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
CR_Ne	48	0.005	0.000	0.001	0.000	0.003	0.000	0.004	0.000	0.000	0.002
CR_Nw	49	0.008	0.001	0.002	0.001	0.005	0.000	0.005	0.000	0.002	0.000
Fourmile	50	0.002	0.000	0.000	0.000	0.000	0.000	0.003	0.000	0.000	0.001
Dixon	51	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Farris	52	0.003	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000
Wood_Hawk2	53	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000
Wood_Hawk1	54	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Wood	55	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Wood_BLM	56	0.014	0.004	0.002	0.006	0.004	0.001	0.012	0.000	0.000	0.006
Buck_NW	57	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Buck_West	58	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Buck_07	59	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Parsnip	60	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Marsh/Mud	61	0.000	0.000	0.000	0.060	0.066	0.042	0.063	0.047	0.028	0.020

Table 5b. Pairwise *P* values, continued.

		DESCHUTES									
		Cr_LEast	Cr_Fair	Cr_NoDriv	Cr_07_Bull	Cr_09_Bull	Dilman_EES	Dilman_Pond 7	Dilman_Pond 6	Dilman_Pond 5	Dilman_Pond CAS
		11	12	13	14	15	16	17	18	19	20
Jack_USFS	26	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Jack_2007	27	0.000	0.006	0.001	0.010	0.000	0.000	0.000	0.001	0.000	0.000
Jack_09_Jame	28	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Jack_10_Jame	29	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Kl_BigSprKane	30	0.000	0.009	0.007	0.005	0.000	0.000	0.000	0.001	0.003	0.002
Kl_Corrall	31	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.001	0.000
Kl_SouthGage	32	0.000	0.001	0.001	0.004	0.000	0.000	0.000	0.000	0.001	0.000
Kl_KaneDitch	33	0.000	0.007	0.008	0.011	0.000	0.000	0.002	0.001	0.001	0.002
Kl_Weir	34	0.002	0.008	0.002	0.013	0.000	0.000	0.001	0.001	0.002	0.002
Kl_Devine	35	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Kl_MilCros	36	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Kl_Pen	37	0.000	0.001	0.001	0.001	0.000	0.001	0.000	0.000	0.000	0.000
Kl_Rock	38	0.005	0.019	0.010	0.009	0.000	0.005	0.006	0.003	0.008	0.004
Kl_Cholo	39	0.000	0.006	0.002	0.004	0.000	0.000	0.000	0.000	0.000	0.000
UWill	40	0.001	0.007	0.007	0.004	0.000	0.000	0.000	0.001	0.000	0.000
Seve_09	41	0.096	0.488	0.182	0.211	0.113	0.078	0.003	0.012	0.004	0.020
Seven10	42	0.000	0.001	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000
SevenMid	43	0.999	0.999	0.999	0.999	0.999	0.999	0.999	0.999	0.999	0.999
SevenLow	44	0.001	0.008	0.019	0.016	0.000	0.001	0.005	0.002	0.002	0.005
CR_CRCK_N01	45	0.002	0.021	0.008	0.013	0.000	0.000	0.005	0.000	0.006	0.003
CR_Found2007	46	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
CR_mys	47	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
CR_Ne	48	0.002	0.008	0.007	0.011	0.000	0.000	0.002	0.001	0.001	0.001
CR_Nw	49	0.000	0.027	0.017	0.021	0.001	0.001	0.001	0.003	0.005	0.004
Fourmile	50	0.000	0.011	0.003	0.008	0.000	0.001	0.000	0.000	0.000	0.000
Dixon	51	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Farris	52	0.000	0.006	0.003	0.010	0.000	0.000	0.000	0.001	0.001	0.000
Wood_Hawk2	53	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Wood_Hawk1	54	0.000	0.001	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000
Wood	55	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Wood_BLM	56	0.001	0.029	0.021	0.029	0.000	0.001	0.004	0.000	0.008	0.008
Buck_NW	57	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Buck_West	58	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Buck_07	59	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Parsnip	60	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Marsh/Mud	61	0.075	0.146	0.024	0.162	0.050	0.000	0.000	0.000	0.000	0.007

Table 5b. Pairwise *P* values, continued.

		DESCHUTES				
		LitDesch_BLM	LitDesc100	GoldLake	ScottyBig	BigMarsh
		21	22	23	24	25
Jack_USFS	26	0.000	0.000	0.000	0.000	0.000
Jack_2007	27	0.001	0.000	0.000	0.000	0.000
Jack_09_Jame	28	0.000	0.000	0.000	0.000	0.000
Jack_10_Jame	29	0.000	0.000	0.000	0.000	0.000
Kl_BigSprKane	30	0.005	0.001	0.000	0.001	0.000
Kl_Corrall	31	0.000	0.000	0.000	0.000	0.000
Kl_SouthGage	32	0.002	0.000	0.000	0.000	0.000
Kl_KaneDitch	33	0.005	0.000	0.000	0.001	0.000
Kl_Weir	34	0.005	0.001	0.000	0.000	0.000
Kl_Devine	35	0.000	0.000	0.000	0.000	0.000
Kl_MilCros	36	0.000	0.000	0.000	0.000	0.000
Kl_Pen	37	0.000	0.000	0.000	0.000	0.000
Kl_Rock	38	0.005	0.001	0.003	0.003	0.000
Kl_Cholo	39	0.000	0.000	0.000	0.000	0.000
UWill	40	0.002	0.000	0.001	0.001	0.000
Seve_09	41	0.131	0.001	0.005	0.000	0.007
Seven10	42	0.000	0.000	0.000	0.000	0.000
SevenMid	43	0.999	0.999	0.999	0.999	0.999
SevenLow	44	0.017	0.000	0.003	0.000	0.000
CR_CRCK_N01	45	0.011	0.001	0.004	0.004	0.000
CR_Found2007	46	0.000	0.000	0.000	0.000	0.000
CR_mys	47	0.000	0.000	0.000	0.000	0.000
CR_Ne	48	0.006	0.000	0.001	0.001	0.000
CR_Nw	49	0.006	0.000	0.002	0.001	0.001
Fourmile	50	0.001	0.000	0.000	0.001	0.000
Dixon	51	0.000	0.000	0.000	0.000	0.000
Farris	52	0.000	0.000	0.001	0.000	0.000
Wood_Hawk2	53	0.001	0.000	0.000	0.000	0.000
Wood_Hawk1	54	0.000	0.000	0.000	0.000	0.000
Wood	55	0.000	0.000	0.000	0.000	0.000
Wood_BLM	56	0.006	0.004	0.002	0.004	0.001
Buck_NW	57	0.000	0.000	0.000	0.000	0.000
Buck_West	58	0.000	0.000	0.000	0.000	0.000
Buck_07	59	0.000	0.000	0.000	0.000	0.000
Parsnip	60	0.000	0.000	0.000	0.000	0.000
Marsh/Mud	61	0.008	0.000	0.000	0.000	0.000

Table 6. Analysis of Molecular Variance (AMOVA) of *Rana pretiosa* sites supports the partition of genetic variation between Deschutes and Klamath Basins. See Table 1 and Figure 1 for site and cluster information. * = $P < 0.001$

Source of Variation	d.f.	Sum of squares	Variance components	Percentage of Variation
Among clusters	1	621.140	0.927	39.87*
Among sites within clusters	59	492.010	0.341	14.69*
Within sites	1255	1326.951	1.057	45.44*

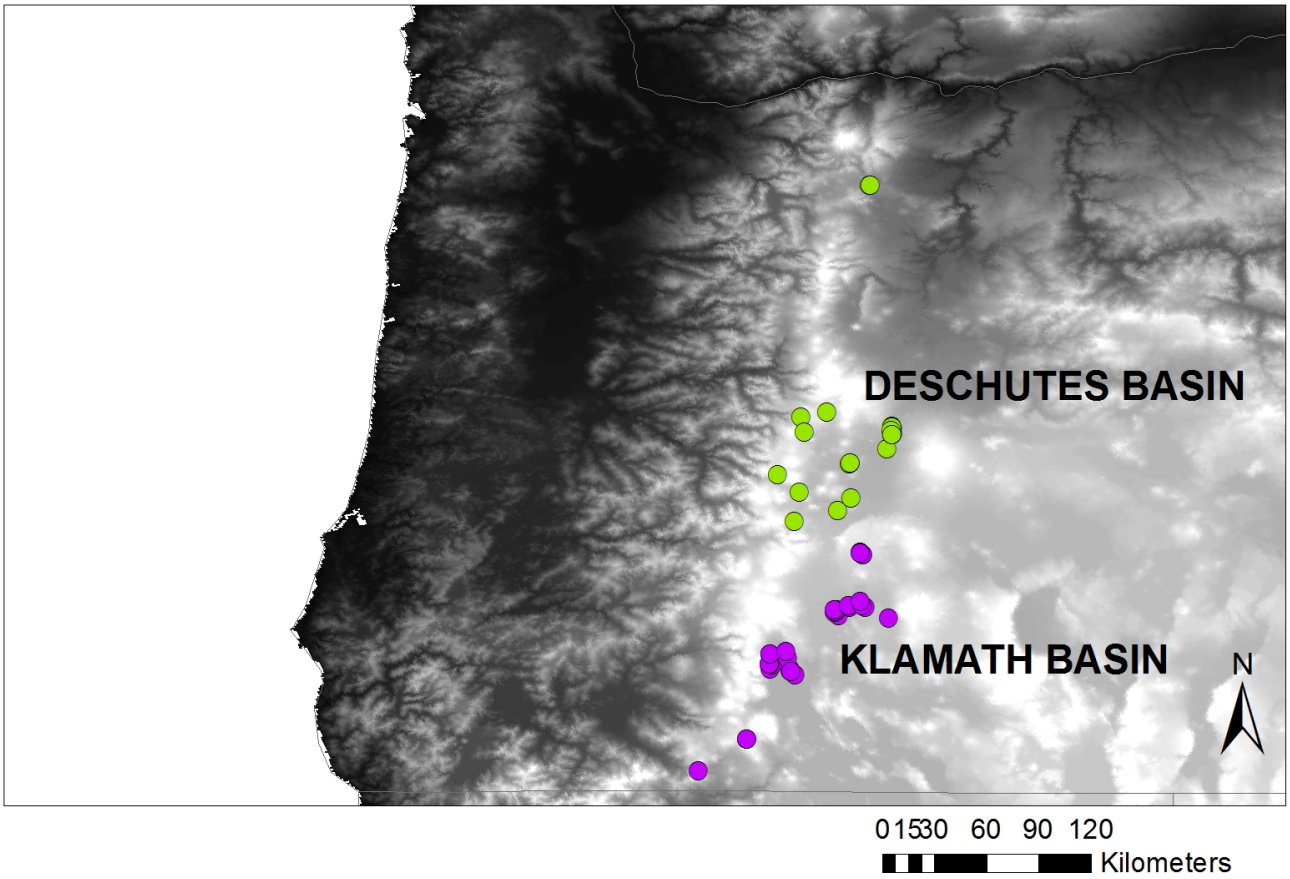

Figure 1. Sampling sites for *Rana pretiosa* in Oregon. The analyses, based on multilocus genotypes, supports two major genetic groups: Deschutes Basin and Klamath Basin. Topographic relief shown from white (high elevation) to dark (low elevation). Drawn from ArcGIS v 9.3.1.

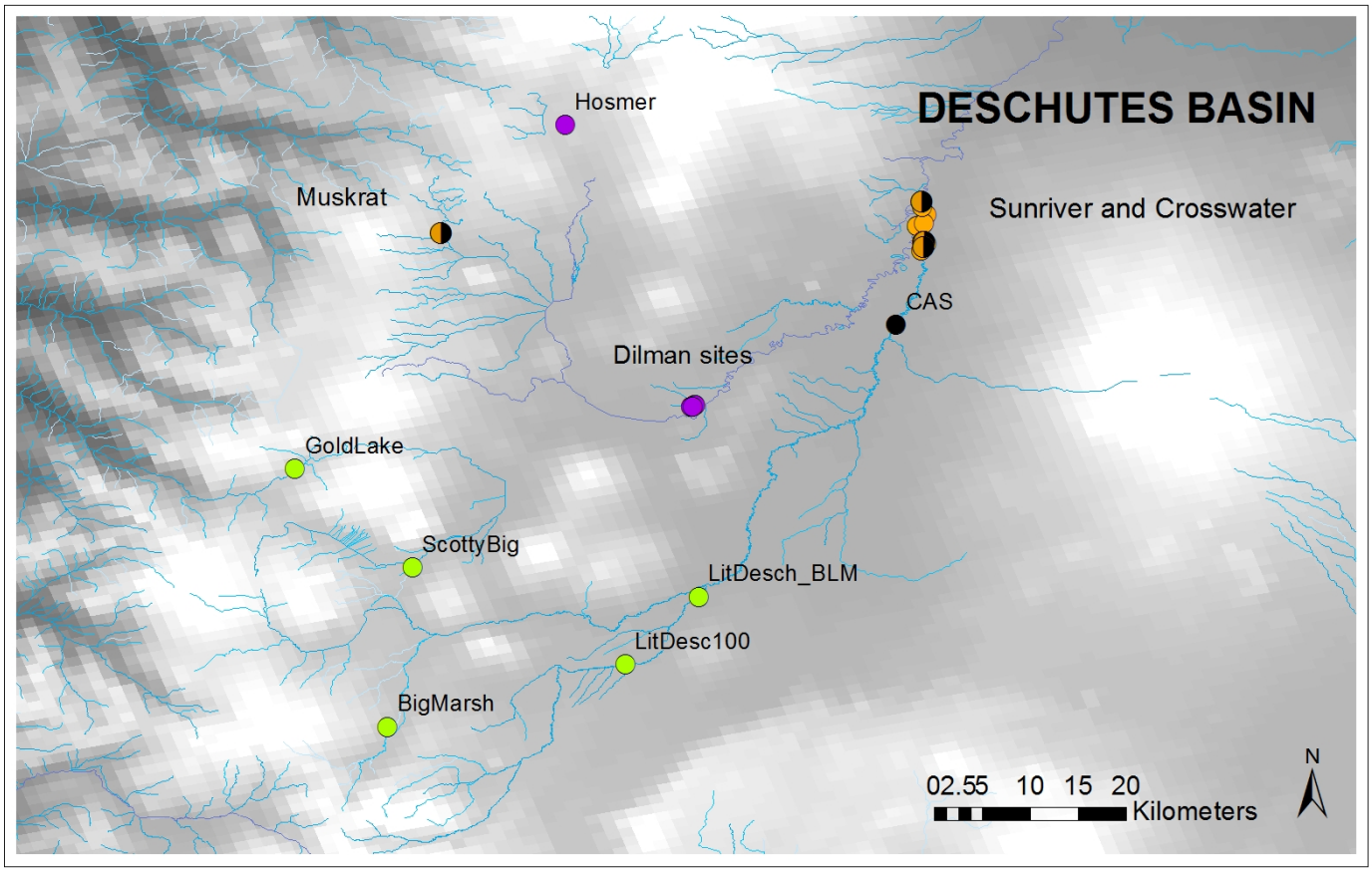

Figure 2. Population assignment of four genetic clusters for Deschutes Basin sites, based on STRUCTURE analyses. The presence of admixed genetic clusters shown as dichromatic circles, otherwise, genetic clusters represented as distinct colors. CAS individuals assigned to 5 different clusters, not shown here (but see Table 1). See Table 1 for site abbreviations.

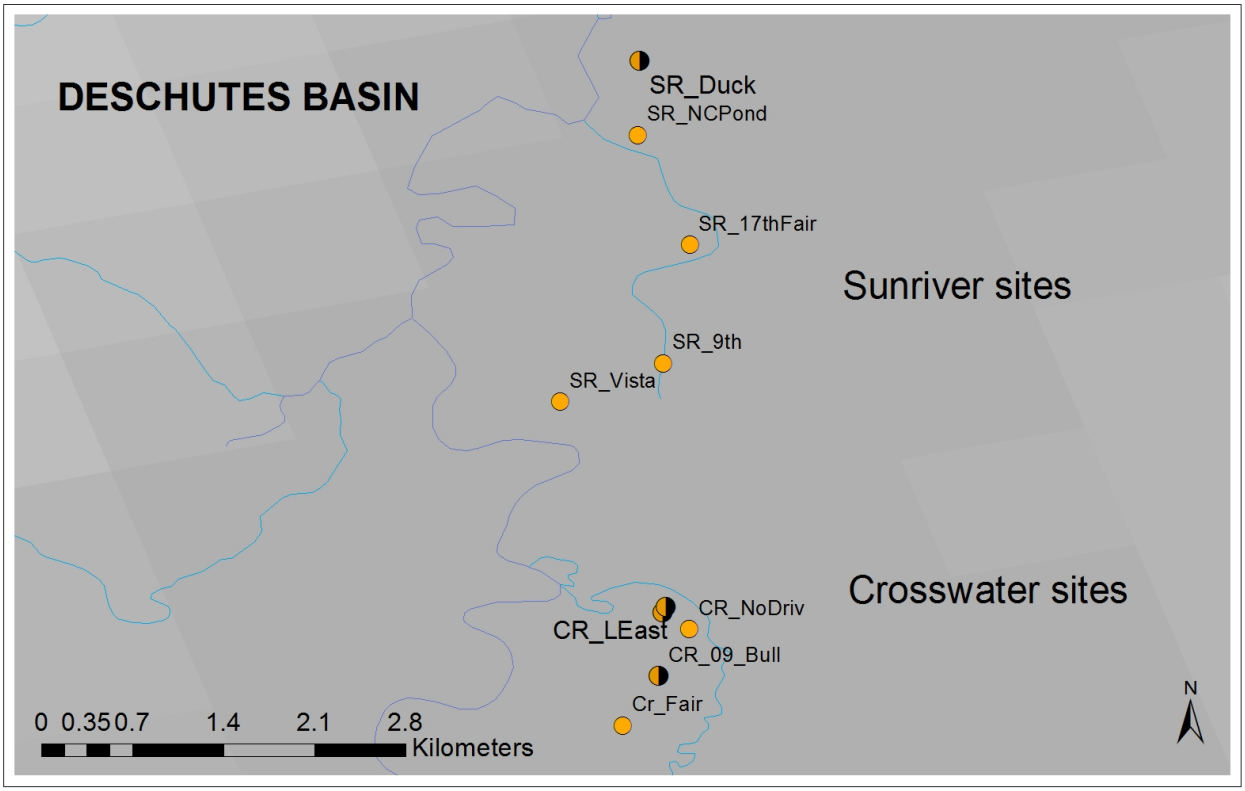

Figure 3. Population assignment of two clusters for Sunriver and Crosswater Creek sites in the Deschutes Basin, based on STRUCTURE analyses. The presence of admixed genetic clusters shown as dichromatic circles, otherwise, genetic clusters represented as distinct colors. See Table 1 for site abbreviations.

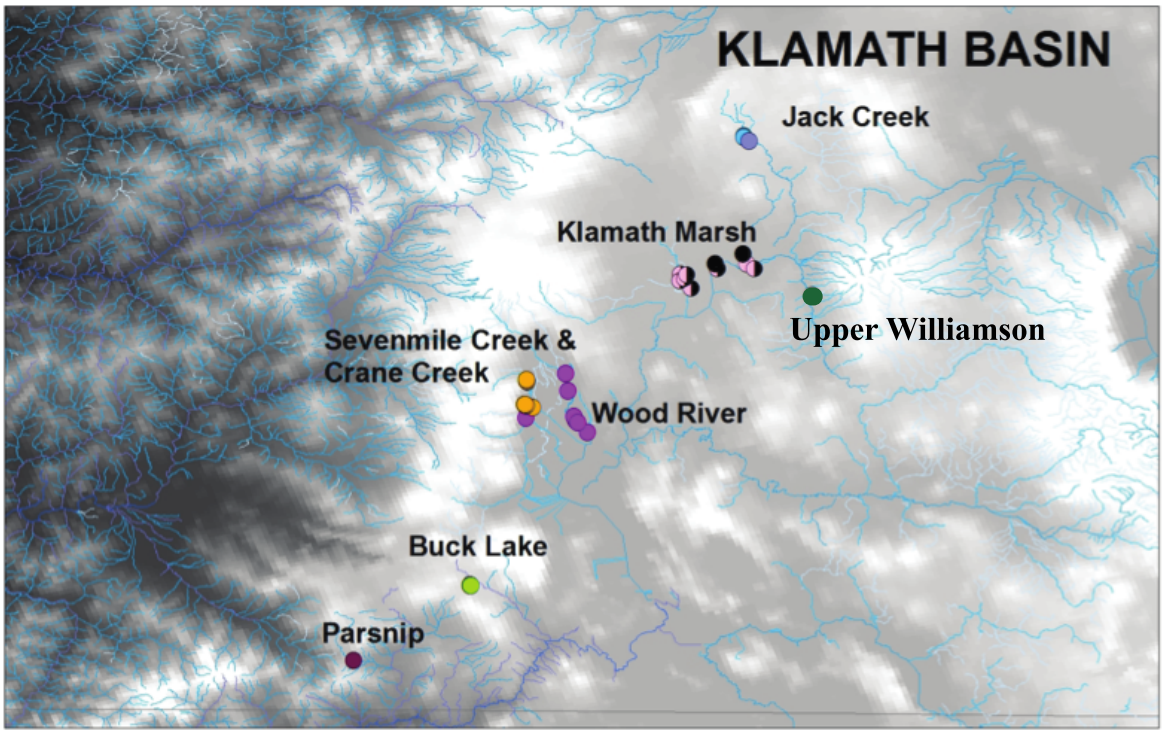

Figure 4. Population assignment of seven genetic clusters for *Rana pretiosa* in the Klamath Basin, based on STRUCTURE results. The presence of admixed genetic clusters shown as dichromatic circles, otherwise, genetic clusters represented as distinct colors. Upper Williamson contains individuals assigned to three different clusters (see Table 1).

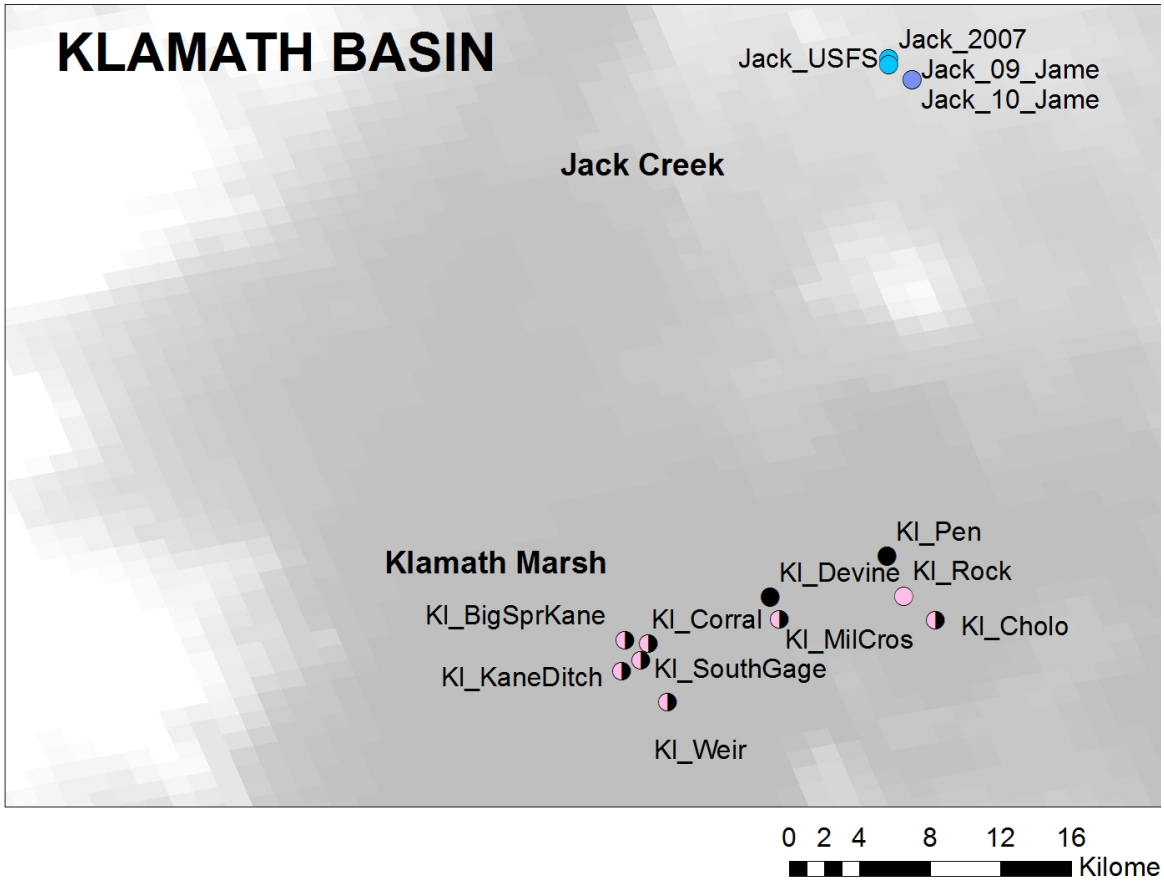

Figure 5. Population assignment of genetic clusters for Jack Creek and Klamath Marsh sites in the Klamath Basin, based on STRUCTURE analyses. The presence of admixed genetic clusters shown as dichromatic circles, otherwise, genetic clusters represented as distinct colors. See Table 1 for site abbreviations.

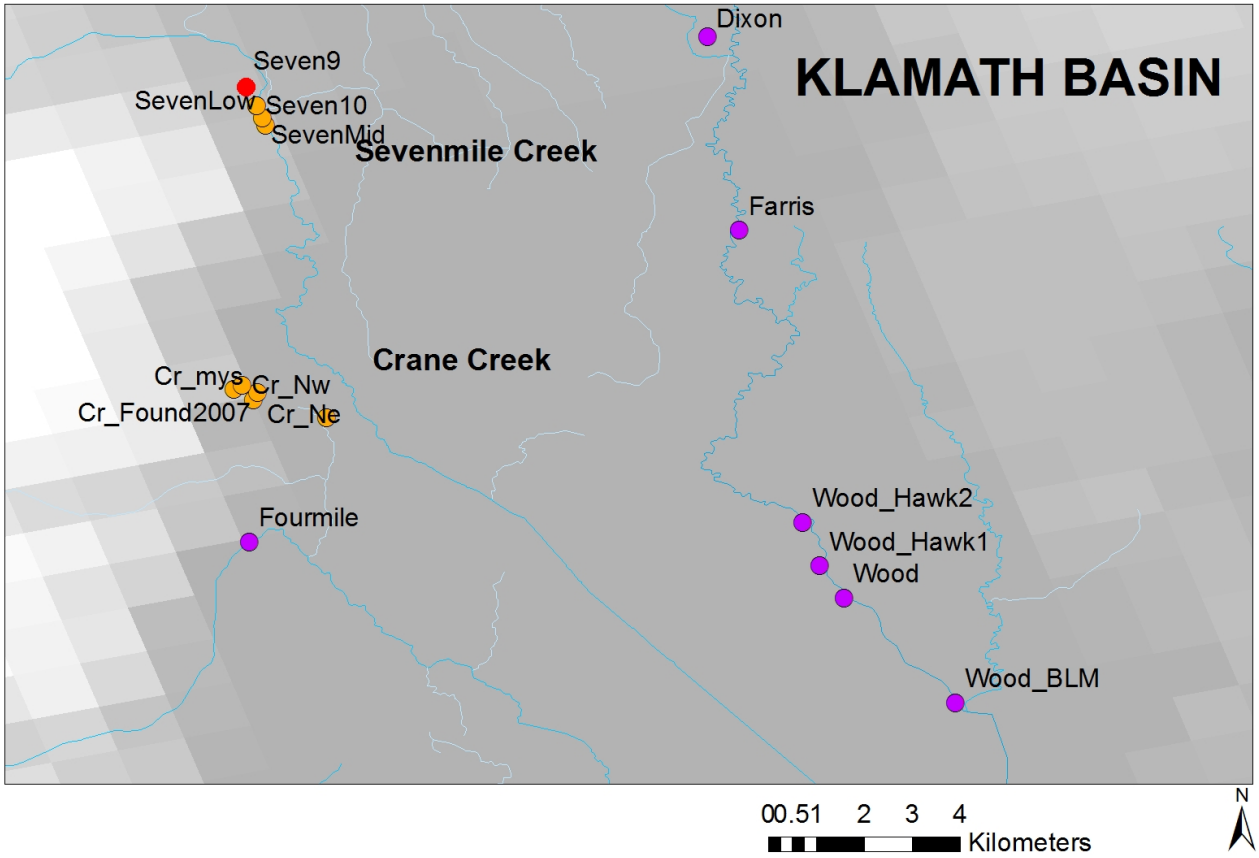

Figure 6. Population assignment of genetic clusters for Sevenmile Creek, Crane Creek and Wood River sites in the Klamath Basin, based on STRUCTURE analyses.