

# New Mexico Boreal Toad Repatriation 2010 (Year Three)



Photograph: L. Pierce, NMDGF



Photograph: L. Pierce, NMDGF



Photograph: J. Stuart, NMDGF



## **Introduction**

This is a report on the third year of the program to repatriate Boreal Toad to Trout Lakes in Rio Arriba County, NM. These efforts followed the development of a recovery plan for New Mexico, formation of a recovery team in the state, extensive interaction with the Colorado recovery team, and interaction with the US Forest Service (USFS), on whose property Trout Lakes are situated. Included in the report are a time-line of events during the third year, notes on how toads were processed when captured, results of testing for presence of a chytrid fungus (*Batrachochytrium dendrobatidis*, hereafter, "Bd"), field notes from the monitoring efforts, maps and photographs, a checklist of other species observed, proposed activities for the 4<sup>th</sup> year of the repatriation effort, and a list of potential research questions based upon observations to date. In December 2009, results of Bd samples came back positive for the fungus. During subsequent discussions among the New Mexico Boreal Toad Recovery Team and a conference call on 24 March 2010, it was determined to continue repatriating the species at the original site. The intent of the program would be a selection experiment in the hopes of developing a line of toads at least partially resistant to Bd. Other sites, more remote and thus less likely to be infected by Bd, would be sought out as future repatriation sites.

## **Summary of Season**

Surveys were conducted as soon as road in to Trout Lakes was passable, starting 26 May 2010, when multiple 1-year old toads were found. Toads were caught and observed throughout the season, with 27 sampled for Bd. Two toads from 2008 were captured, one 258 m away from the Repatriation Pond at the Upper Fishing Pond and one 414 m away from the Repatriation Pond at the Lower Fishing Ponds. Toads were observed in multiple ponds in the region, indicative of dispersal by the repatriated population.

Almost 1,500 tadpoles were repatriated in 2010, arriving in two sub-cohorts. The first sub-cohort was delivered on 9 June 2010, directly from the Colorado Division of Wildlife Native Aquatic Species Restoration Facility (NASRF) in Alamosa to the Repatriation Pond. Arrangements were made with New Mexico Game and Fish (NMDGF) Los Ojos Fish Hatchery to house and maintain the 2<sup>nd</sup> sub-cohort of tadpoles for one week to for further growth prior to release into the Repatriation Pond. Tadpoles were delivered from NASRF to the Hatchery in Los Ojos on 21 July and the tadpoles were released at Trout Lakes on 29 July 2010. Toadlets from both sub-cohorts were observed.

	Day	700	715	725	735	745	755	765	775	785	795	805	815	825	835
2008 Cohort (2-year olds)	Day														
2009 Cohort (1-year olds)	Day	320	335	345	355	365	375	385	395	405	415	425	435	445	455
2010 Sub-cohort No. 1			0	10	20	30	40	50	60	70	80	90	100	110	120
2010 Sub-cohort No. 2								0	10	20	30	40	50	60	
Month		May	June		July			August			Sept.				Oct.
Boreal Toad		1-year old (2009) Toads Observed							2-year old (2008) Toads Obs.						
Los Ojos Hatchery (Sub-cohort 2)									LO Hatch						
Amphibians		Chorus Frogs Observed							Northern Leopard Frogs Observed						
Fathead Minnows		Adults Present							Fry Present						
Weather		Last Snow		Dry Period			Marshes Flooded					Snow			
Human Activity		Fishing							Hunting						
Capture Rate (toads/person-hour)		3.3	8.5		6.0						0.1				

**Table 1. Time-line for 2010 boreal toad repatriation season.**

### Summary of Repatriation

The New Mexico Boreal Toad Recovery Team determined to follow the same repatriation process as in 2009, whereby tadpoles would be delivered to the NMDGF Los Ojos Hatchery to further accrue size before being released at the Repatriation Pond. The Recovery Team moved to continue the same program as a selection experiment to develop a line of toads resistant to some degree to Bd, whereby the breeding adults would not be exposed to the fungus, only the offspring; those offspring that are resistant would, in theory, then reproduce themselves, creating the Bd-resistant lineage.

Two sets of tadpoles (hereafter, sub-cohorts) were produced for New Mexico at NASRF. A shift to using warmer water at NASRF led to production of much larger tadpoles. Due to the rapid growth rate of the tadpoles in the warmer water, the first sub-cohort of tadpoles were deemed too close to metamorphosis to risk moving to the NMDGF Los Ojos Hatchery, which did not have the facilities to house toadlets. Therefore 1,114 tadpoles were delivered directly from NASRF to Trout Lakes on 9 June. A second sub-cohort of tadpoles, also very large, were delivered to Los Ojos on 21 July. Soon after the monsoon season began in northern New Mexico; given concern the road up to Trout Lakes would soon be made impassable from rain, the second sub-cohort, 337 tadpoles, were delivered to the Repatriation Pond earlier than planned, on 29 July. The first, June sub-cohort came from eggs collected in Chaffee County, CO, while the second, July sub-cohort came from breeder adult Boreal Toads from Mineral County, CO. See Figure 1.

Toadlets from both sub-cohorts were subsequently observed, but no reliable estimate for how many tadpoles exited the Repatriation Pond could be made.

### Summary of Monitoring

Toads were observed throughout the field season, from the end of May to the end of September. Two patterns developed. The first pattern came later in the field season, when two 2-year old toads were captured. Both individuals from the 2008 cohort were found in dense reed-like zones by ponds with considerably more cover than where 1-year old toads and toadlets were observed. See Figure 5. The second pattern, throughout the field season, concerns the toads dispersing throughout the area, including a pond originally slated to be the

repatriation site in 2007 but was dry in 2008, returning to form in 2009; a pond north of the Repatriation Pond where a dead toad had been found the previous season; at the Upper Fishing Pond, 241 and 258 meters away from the Repatriation Pond on a straight line; and down to the Lower Fishing Ponds, 414 m away from the Repatriation Pond on a straight line. See Table 2 and Figure 3. Spring runoff to the area was heavy, producing flooded ponds, ponds that had breached, and deep streams. Snow still remained by the end of May in the shadows. June and early July were dry, leading to a sharp reduction in the size of the Repatriation Pond. The monsoon season returned during the last week of July, with an additional pulse at the end of August, pushing the Repatriation Pond near to over-flowing, as well as filling the marshes with water.

### **Processing of Toads**

Each 2-year old and 1-year old toad was measured for snout-Vent Length (SVL) and Gape Width (GW). Two- and one-year old toads were also given a unique combination of toe-clips to identify recaptures until such time that the toads attain sufficient size to accept a Passive Integrated Transponder (PIT tag). Additionally, 2-year old and 1-year old toads were swabbed for Bd. When possible, photographs were taken of the bellies of 2-year old and 1-year old toads, as well as 2010 toadlets to further explore using this process for recapture identification. Please see Figure 10 for an example of the field sheet used, which includes the marking scheme for toe-clipping 2- and 1-year old toads.

### **Chytrid Fungus**

Amphibians caught during the field season were swabbed for Bd. Only Chorus Frogs and Boreal Toads were captured in 2010 (leopard frogs were seen but none caught). Samples for Bd were sent to Pisces Molecular, LLC. Results were as follows: 18 of 27 Boreal Toads sampled for Bd came back positive (66.7%), meaning the fungus was detected in sample. The degree to which Bd was detected varied: of those testing positive for Bd, 8 (44.4% of positive subset, 29.6% of overall set) were very strongly positive, 5 (27.8%, 18.5%) were strongly positive, 3 (16.7%, 11.1%) were positive, and 2 (11.1%, 7.4%) weakly positive. One of the two toads from the 2008 cohort captured tested strongly positive for Bd, while the other came back negative. See Table 2 & Figure 4. Of the 4 Chorus Frogs sampled, 2 came back strongly positive for Bd, 2 came back negative for the fungus. Unlike 2009, no dead toads were found.

### **Field Notes**

26 May 2010 (Day 708 for Boreal Toad tadpole cohort released in 2008; Day 322 for 2009 cohort):

*Purpose of Visit:* Initial survey to determine if Boreal Toads were active

*Climate Conditions:* Partly cloudy and warm, with occasional gust of wind or slight breeze. Snow still present in shadowed areas.

*Repatriation Pond and Marsh Conditions:* Marshy areas mostly dry.

*Stream-flow Conditions:* Multiple streams from snow runoff along road to Trout Lakes, wide, deep and fast-flowing. Streams into and out of Repatriation Pond also fast-flowing and deep. Multiple ephemeral ponds present along road. Middle Upper Pond (see Figure 2) had burst to the south due to high stream flow.

***Boreal Toad:*** Two 2009 toads observed, one by Secondary Pond (see Figure 2) one by Repatriation Pond, during single person 20 minute surveys (3.3 toads/person-hours). No eggs or tadpoles observed.

*Insect Observations:* No adult dragonflies or butterflies present. Diving beetles and leeches active in Repatriation Pond.

*Fish Observations:* Fathead minnows present in Repatriation Pond, including one male in full breeding color.

*Amphibian Observations (not including Boreal Toad):* Chorus Frogs calling, and three morphs observed (brown, green and white, and green). No leopard frogs observed.

*Reptile Observations:* None observed.

*Bird Observations:* Potential juvenile Golden Eagle sighted 3 miles down from Trout Lakes in afternoon. Other species observed included Mallard, Northern Flicker, Black-billed Magpie, American Robin, and Violet-green Swallow.

*Mammal Observations:* Least Chipmunk, Abert's Squirrel, and 2 Elk observed on road up to Trout Lakes. No cattle observed.

*Human Observations:* One truck exiting the lakes.

*Personnel Present:* L. Pierce, NMDGF

3 June 2010 (Day 716 for Boreal Toad tadpole cohort released in 2008; Day 330 for 2009 cohort):

*Purpose of Visit:* Surveys for Boreal Toads, and Bd sampling of all amphibians caught.

*Climate Conditions:* Mostly clear and sunny, with occasional breeze. Snow no longer present.

*Repatriation Pond and Marsh Conditions:* Marshy areas mostly dry with pockets of mud and water.

*Stream-flow Conditions:* Stream-flow reduced from 26 May but still strong. Streams into and out of Repatriation Pond also fast-flowing and deep. Most ephemeral ponds present along road beginning to dry up.

***Boreal Toad:*** Ten toads caught and three additional toads observed around Repatriation Pond over 30 minutes by 2 trained herpetologists (13 toads/person-hour). Four toads caught and two additional toads observed around Secondary Pond over 30 minutes by 2 trained herpetologists (6 toads/person-hour). Total of 14 toads caught and 5 more observed (8.5 toads/person-hour). No eggs or tadpoles observed. One 2009 toad observed at marsh that was the first site selected for repatriation in 2007, prior to the marsh drying up due to beaver activity upstream; the beavers released water back to marsh in 2009 and it has remained as such since (see Figure 2).

*Insect Observations:* Dragonfly, damselfly and butterfly adults present, though in very low numbers. Diving beetles active in Repatriation Pond.

*Fish Observations:* Fathead minnows present in Repatriation Pond.

*Amphibian Observations (not including Boreal Toad):* Chorus Frogs calling, and 2 captured at Repatriation Pond and 2 more at Secondary Pond. Northern Leopard Frog observed at Main Fishing Pond at 1344 M DST.

*Reptile Observations:* None observed.

*Bird Observations:* Mallard nest discovered near Repatriation Pond. Other species observed included Northern Flicker, Stellar's Jay, Common Raven, Black-billed Magpie, American Robin, Chipping Sparrow (heard), Song Sparrow (heard), and Violet-green Swallow.

*Mammal Observations:* Least Chipmunk, and Rock Squirrel observed on road up to Trout Lakes, as were cattle. Voles and Western Jumping Mouse observed at Lower Fishing Pond (See Figure 2).

*Human Observations:* One set of fishermen at Main Fishing Pond in AM, two sets in PM.

*Personnel Present:* J. Stuart, L. Pierce, NMDGF

9 June 2010 (Day 722 for Boreal Toad tadpole cohort released in 2008; Day 336 for 2009 cohort):

*Purpose of Visit:* Delivery of 1,114 tadpoles from NASRF, placed in Repatriation Pond.

*Climate Conditions:* Mostly clear and very warm.

*Repatriation Pond and Marsh Conditions:* Marshy areas mostly dry with pockets of mud and water. Repatriation Pond greatly reduced, while Secondary Pond remained full.

*Stream-flow Conditions:* Greatly reduced.

***Boreal Toad:*** Four – five 2009 toads observed. Large toads, potential 2008 cohort, observed but not captured, near Secondary Pond. No eggs or tadpoles observed.

*Insect Observations:* Dragonfly, damselfly and butterfly adults present. Mourning Cloak butterflies prevalent on road out.

*Fish Observations:* Fathead minnows present in Repatriation Pond.

*Amphibian Observations (not including Boreal Toad):* No amphibians heard or observed.

*Reptile Observations:* None observed.

*Bird Observations:* Northern Flicker observed.

*Mammal Observations:* No mammals observed, including cattle.

*Human Observations:* One fisherman/camper at Main Fishing Pond in AM plus additional fisherman following vehicles in to lakes. Truck observed heading up to lakes in PM.

*Personnel Present:* E. Davinroy, CO DOW; L. Pierce, NMDGF



22 June 2010 (Day 735 for Boreal Toad tadpole cohort released in 2008; Day 349 for 2009 cohort; Day 13 for 1<sup>st</sup> 2010 sub-cohort):

*Purpose of Visit:* Surveys for Boreal Toads, and Bd sampling of all amphibians caught.

*Climate Conditions:* Warm and dry, partly to mostly cloudy, with occasional breezes.

*Repatriation Pond and Marsh Conditions:* Marshy areas mostly dry with pockets of mud and water. Repatriation Pond greatly reduced, while Secondary Pond remained full.

*Stream-flow Conditions:* Greatly reduced.

**Boreal Toad:** Nine toads caught around Repatriation and Secondary ponds, three from the latter over 30 minutes by 2 trained herpetologists and 1 trained biologist (6 toads/person-hour). Another toad captured and tested for Bd from the North Pond, where a dead toad was found in 2009 (see Figure's 2 & 3). 2010 cohort of tadpoles showing legs and very large in size, 500 – 1000 observed.

*Insect Observations:* Dragonfly, damselfly and butterfly adults present. Insect activity greatly increased. Dragonflies and damselflies observed included Traiga Bluet, 4-spotted Skimmers, and Boreal Whiteface. Horseflies also prevalent.

*Fish Observations:* Fathead minnows present in Repatriation Pond, including fry.

*Amphibian Observations (not including Boreal Toad):* One Northern Leopard Frog observed at Repatriation Pond, two more at Main Fishing Pond, and many observed at Lower Fishing Ponds.

*Reptile Observations:* None observed.

*Bird Observations:* Birds observed included Turkey Vulture, Belted Kingfisher, Northern Flicker, Black-billed Magpie, Common Raven, American Robin, and Yellow-rumped Warbler.

*Mammal Observations:* Golden-mantled Ground-squirrel and Least Chipmunk observed on road up to the lakes, as were cattle, which were very prevalent.

*Human Observations:* One fisherman at Main Fishing pond in PM.

*Personnel Present:* R. Jankowitz, J. Stuart, L. Pierce, NMDGF

21 July 2010:

Delivery of 337 tadpoles from NASRF to NMDGF Los Ojos Hatchery. See Figures 8 & 9.

22 July 2010 (Day 765 for Boreal Toad tadpole cohort released in 2008; Day 379 for 2009 cohort; Day 43 for 1<sup>st</sup> 2010 sub-cohort):

*Purpose of Visit:* Surveys for Boreal Toads, and Bd sampling of all amphibians caught.

*Climate Conditions:* Partly cloudy and cool, with rains pending. Roads in damp from previous rains.

*Repatriation Pond and Marsh Conditions:* Marshy areas damp. Repatriation Pond back to normal depth, while Secondary Pond remained full.

*Stream-flow Conditions:* Much improved from 22 June.

***Boreal Toad:*** Five 2009 toads observed near Repatriation Pond, and three 2010 toadlets (one deceased) observed between Repatriation and Secondary Pond. No measure of effort (toads/person-hour) available due to haphazard fashion and variability of expertise in individuals doing surveys. 2009 toad captured at Upper Fishing Pond while 2008 toad caught at Lower Fishing Pond (see Figure 3). No eggs or tadpoles observed.

*Insect Observations:* Dragonfly, damselfly and butterfly adults present. Insect activity steady from previous month. Dragonflies and damselflies observed included Boreal Whiteface, though in greatly reduced numbers (one collected and delivered to University of New Mexico Museum of Southwestern Biology). Paddle-tailed Darner Dragonflies very prevalent. Butterflies included various fritillaries, Weidermeyer Admiral.

*Fish Observations:* Fathead minnows present in Repatriation Pond, including fry.

*Amphibian Observations (not including Boreal Toad):* Northern Leopard Frogs observed at Repatriation Pond, Middle and Upper Fishing ponds, and many observed at Lower Fishing Ponds (see Figure 2).

*Reptile Observations:* None observed.

*Bird Observations:* Birds observed included Mallard, Turkey Vulture, Sharp-shinned Hawk, Belted Kingfisher, Northern Flicker, Downey Woodpecker, Black-billed Magpie, American Robin, and swallows.

*Mammal Observations:* Golden-mantled Ground-squirrel and Least Chipmunk observed on road up to the lakes, as were cattle. Red squirrels heard and observed near Repatriation Pond, and voles observed in high numbers both around Repatriation Pond and Lower Fishing Ponds.

*Human Observations:* One fisherman at Main Fishing pond in PM.

*Personnel Present:* D. Shaw, J. Daly, F. Aragon, L. Croessmann, C. Daly, S. Lohman, C. Reardon, & A. Perez-Umphrey, Bosque School; J. Stuart, L. Pierce, NMDGF

29 July 2010 (Day 772 for Boreal Toad tadpole cohort released in 2008; Day 386 for 2009 cohort; Day 50 for 1<sup>st</sup> 2010 sub-cohort):

*Purpose of Visit:* Delivery of 337 tadpoles from NMDGF Los Ojos Hatchery, placed in Repatriation Pond.

*Climate Conditions:* Mostly cloudy and warm, some light rain. Road up to lakes somewhat muddy from previous rains.

*Repatriation Pond and Marsh Conditions:* Marshy areas flooded. Repatriation Pond overflowing, while Secondary Pond remained full.

*Stream-flow Conditions:* Fast-flowing and high.

***Boreal Toad:*** No toads, toadlets, eggs, or tadpoles observed.

*Insect Observations:* Dragonfly, damselfly and butterfly adults present.



*Fish Observations:* Fathead minnows present in Repatriation Pond, including young-of-year.

*Amphibian Observations (not including Boreal Toad):* Northern Leopard Frog caught near Main Fishing Pond, but not sampled for Bd.

*Reptile Observations:* None observed.

*Bird Observations:* Spotted Sandpiper and female Blue Grouse with young observed.

*Mammal Observations:* Golden-mantled Ground-squirrel and Least Chipmunk observed on road up to lakes, as well as cattle.

*Human Observations:* 3 families with RV's stationed at Main Fishing Pond.

*Personnel Present:* J. Martinez, USFS; M. Watson, L. Pierce, NMDGF

25 August 2010 (Day 799 for Boreal Toad tadpole cohort released in 2008; Day 413 for 2009 cohort; Day 77 for 1<sup>st</sup> 2010 sub-cohort, Day 27 for 2<sup>nd</sup> 2010 sub-cohort):

*Purpose of Visit:* Surveys for Boreal Toads.

*Climate Conditions:* Partly cloudy and cool until clouds burned off (mid-day).

*Repatriation Pond and Marsh Conditions:* Marshes somewhat flooded and lush. Repatriation Pond overflowing and lush with vegetation and algae (See Figure 7), while Secondary Pond remained full.

*Stream-flow Conditions:* Slowed from 29 July.

***Boreal Toad:*** Only 2 toadlets seen under cloudy conditions by two trained herpetologists and one biologist during 10 minute survey (0.13 toadlets/person-hour); no toads observed. In subsequent surveys during sunny period, 10-20 toadlets observed in marsh between Repatriation and Secondary Ponds, during haphazard searches. One 2009 toad observed in marshes of Upper Fishing Pond, and one 2008 toad caught there (See Figures 5 & 6). Two more 2009 toads observed in Middle Upper Fishing Pond. No eggs or tadpoles observed.

*Insect Observations:* Dragonfly, damselfly and butterfly adults present, as well as diving beetles and leeches.

*Fish Observations:* Fathead minnows present in Repatriation Pond, including young-of-year.

*Amphibian Observations (not including Boreal Toad):* Northern Leopard Frogs observed near Lower Fishing Ponds

*Reptile Observations:* None observed.

*Bird Observations:* Birds observed included Turkey Vulture, Mallard, Belted Kingfisher, Northern Flicker, Stellar's Jay, American Crow, Common Raven, and American Robin.

*Mammal Observations:* Golden-mantled Ground-squirrel and Least Chipmunk observed on road up to lakes, as well as cattle. Red Squirrel heard around Main Fishing Pond.

*Human Observations:* 4 fishermen at Main Fishing Pond.

*Personnel Present:* C. Hayes, J. Stuart, L. Pierce, NMDGF

## APPENDICES

Date	Locality	ID	Age-Class	Recapture?	Snout-vent Length (mm)	Gape Width (mm)	Mass (g)	Bd Sample Result
3-Jun-10	Repatriation Pond	43	2009	N		9.8	1.9	++
3-Jun-10	Repatriation Pond	44	2009	N	23.4	10.7	2.8	+++
3-Jun-10	Repatriation Pond	101	2009	N	22.5	8.1	0.7	w+
3-Jun-10	Repatriation Pond	102	2009	N	26.5	9.7	1.1	-
3-Jun-10	Repatriation Pond	103	2009	N	26.8	9.3	1.3	+++
3-Jun-10	Repatriation Pond	104	2009	N	22.7	8.4	0.9	-
3-Jun-10	Repatriation Pond	111	2009	N	23.0	8.0	0.8	+
3-Jun-10	Repatriation Pond	112	2009	N	26.3	8.8	2.6	++
3-Jun-10	Repatriation Pond	113	2009	N	20.8	8.6	1.2	+++
3-Jun-10	Repatriation Pond	114	2009	N	22.7	8.2	1.1	-
3-Jun-10	Secondary Pond	121	2009	N	20.4	8.5	1.3	+
3-Jun-10	Secondary Pond	122	2009	N	28.0	11.0	2.2	+
3-Jun-10	Secondary Pond	123	2009	N	25.8	8.9	1.6	-
3-Jun-10	Secondary Pond	124	2009	N	21.8	7.7	0.6	w+
22-Jun-10	Repatriation Pond	131	2009	N	30.1	10.4	3.3	-
22-Jun-10	Repatriation Pond	132	2009	N	27.2	8.1	1.5	++
22-Jun-10	Repatriation Pond	133	2009	N	24.8	8.7	1.5	++
22-Jun-10	Repatriation Pond	134	2009	N	26.2	9.3	1.6	+++
22-Jun-10	Repatriation Pond	141	2009	N	23.6	8.1	1.0	-
22-Jun-10	Repatriation Pond	142	2009	Y	30.5	10.7	2.5	+++
22-Jun-10	Secondary Pond	143	2009	Y	31.6	11.2		++
22-Jun-10	Secondary Pond	144	2009	N	23.5	8.2		+++
22-Jun-10	Secondary Pond	201	2009	N	31.1	12.6		-
22-Jun-10	North Pond	202	2009	N	27.9	10.6		-
22-Jul-10	Upper Fishing Pond	203	2009	N	38.4	11.0	3.8	+++
<b>22-Jul-10</b>	<b>Lower Fishing Pond</b>	<b>204</b>	<b>2008</b>	<b>N</b>		<b>13.5</b>	<b>7.1</b>	-
<b>25-Aug-10</b>	<b>Upper Fishing Pond</b>	<b>211</b>	<b>2008</b>	<b>N</b>	<b>48.6</b>	<b>15.9</b>	<b>11.3</b>	<b>+++</b>

**Table 2. Data on toads captured during surveys in 2010, including location information and results of Bd sampling (see Figure 2). Toads from first cohort in 2008 in bold. Key for Bd sample results as follows: '+++ = very strongly positive (for Bd), '++ = strongly positive, '+' = positive, 'w+' = weakly positive, and '-' = negative for the fungus.**

## Figures

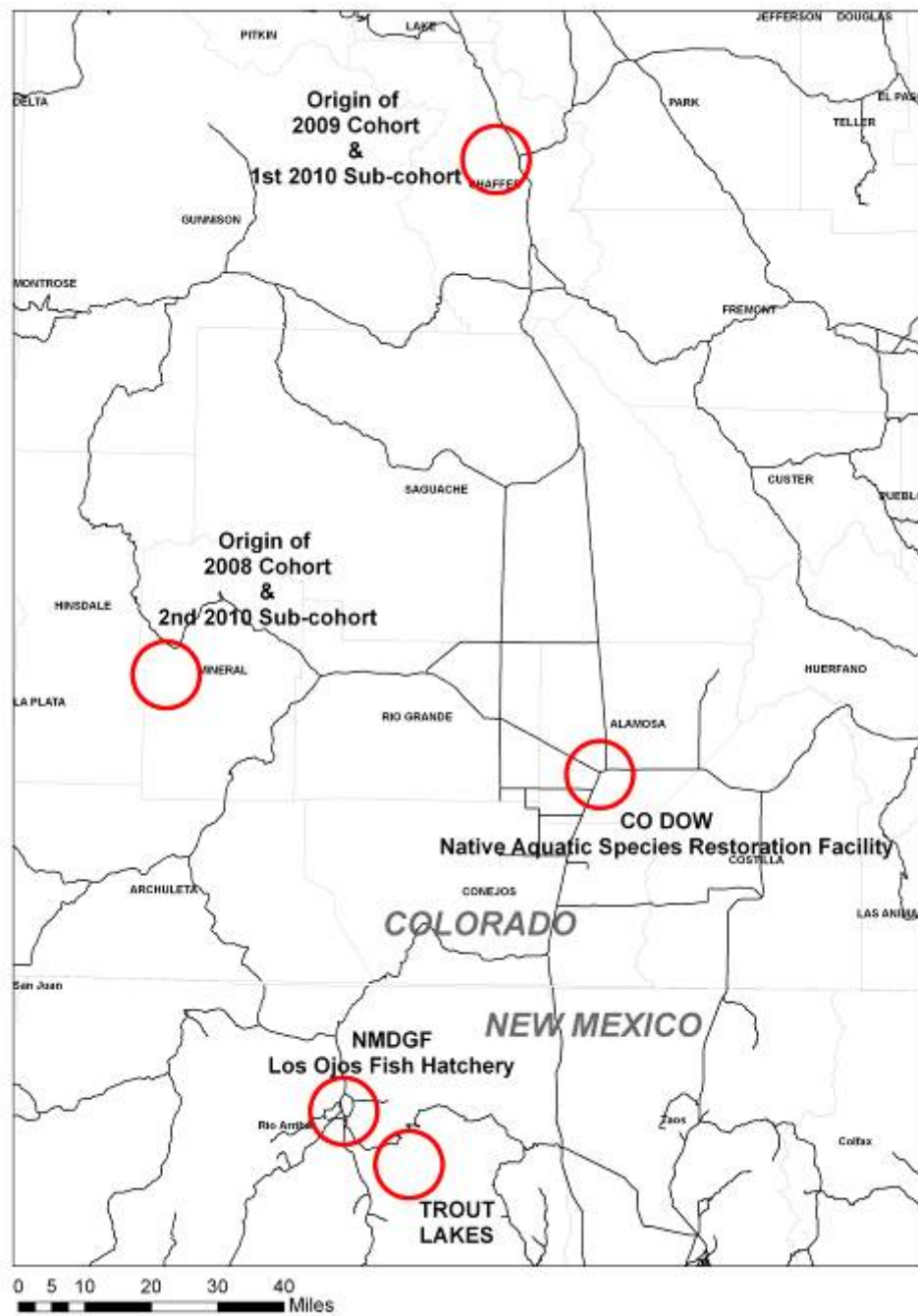


Figure 1. Map of region with pertinent locations identified.

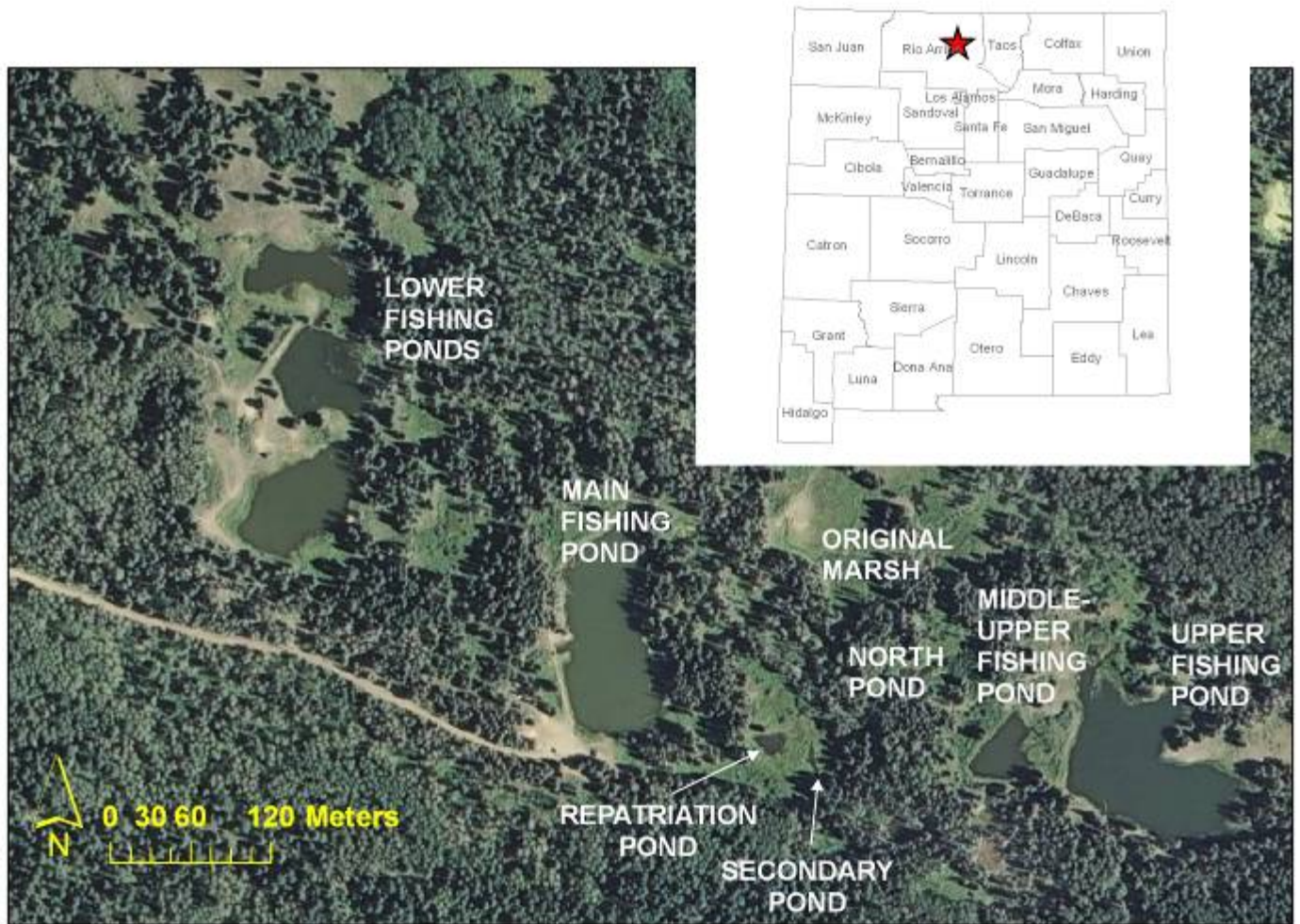


Figure 2. Map of Trout Lakes and location within New Mexico (inset). All names are unofficial, used strictly as references throughout this report. Aerial imagery: 2009 flight of New Mexico through National Agriculture Imagery Program (NAIP).



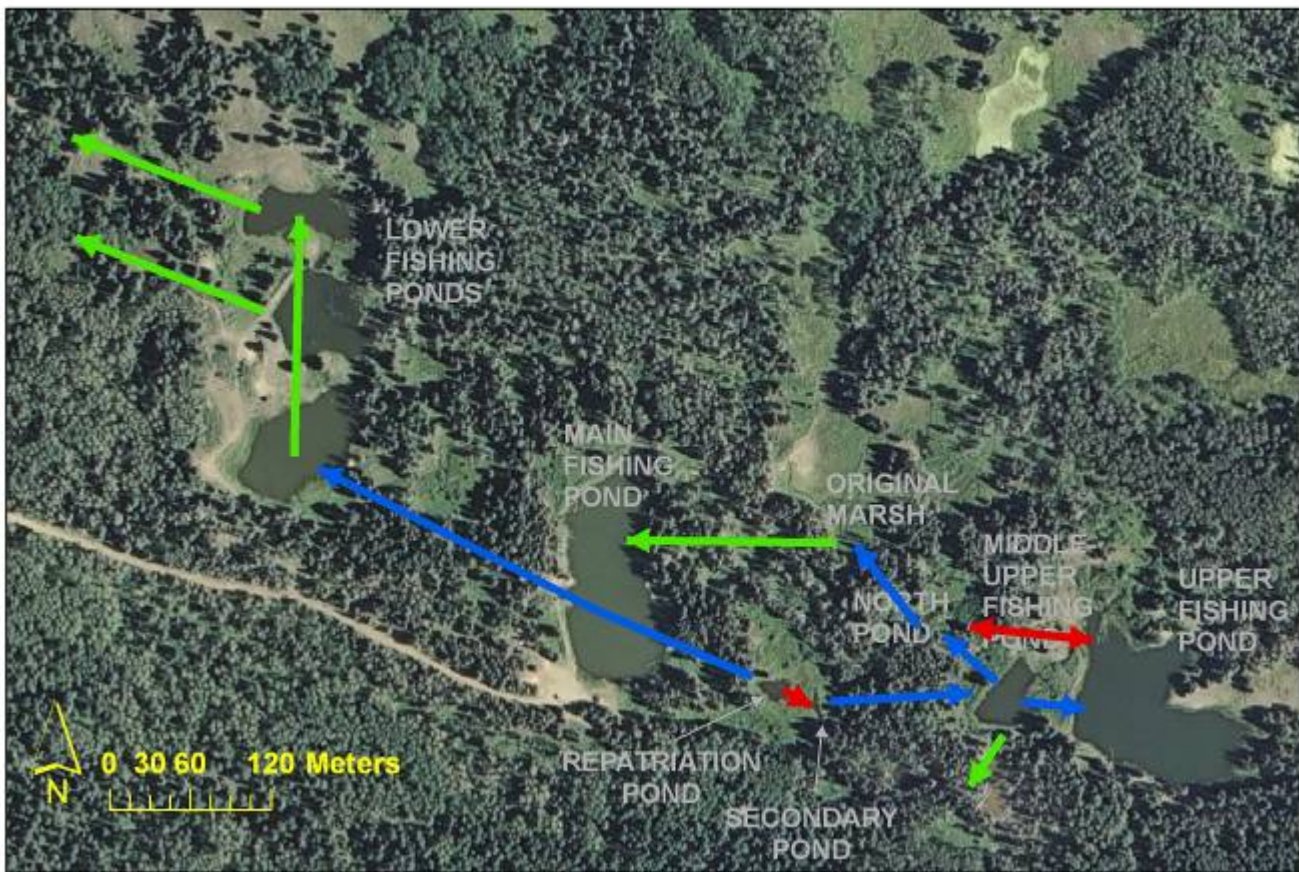


Figure 3. Proposed Dispersal Routes for Boreal Toad at Trout Lakes. Arrows in red are routes confirmed by direct observation of toads or toadlets, arrows in blue are likely dispersal routes that have not been confirmed, and arrows in green are potential routes that warrant further investigation. All routes are in association with streams flowing through the area, flowing from the Upper Fishing Pond (to the right) down through the Repatriation Pond, to the Main Fishing Pond, then on to the Lower Fishing Ponds and beyond.

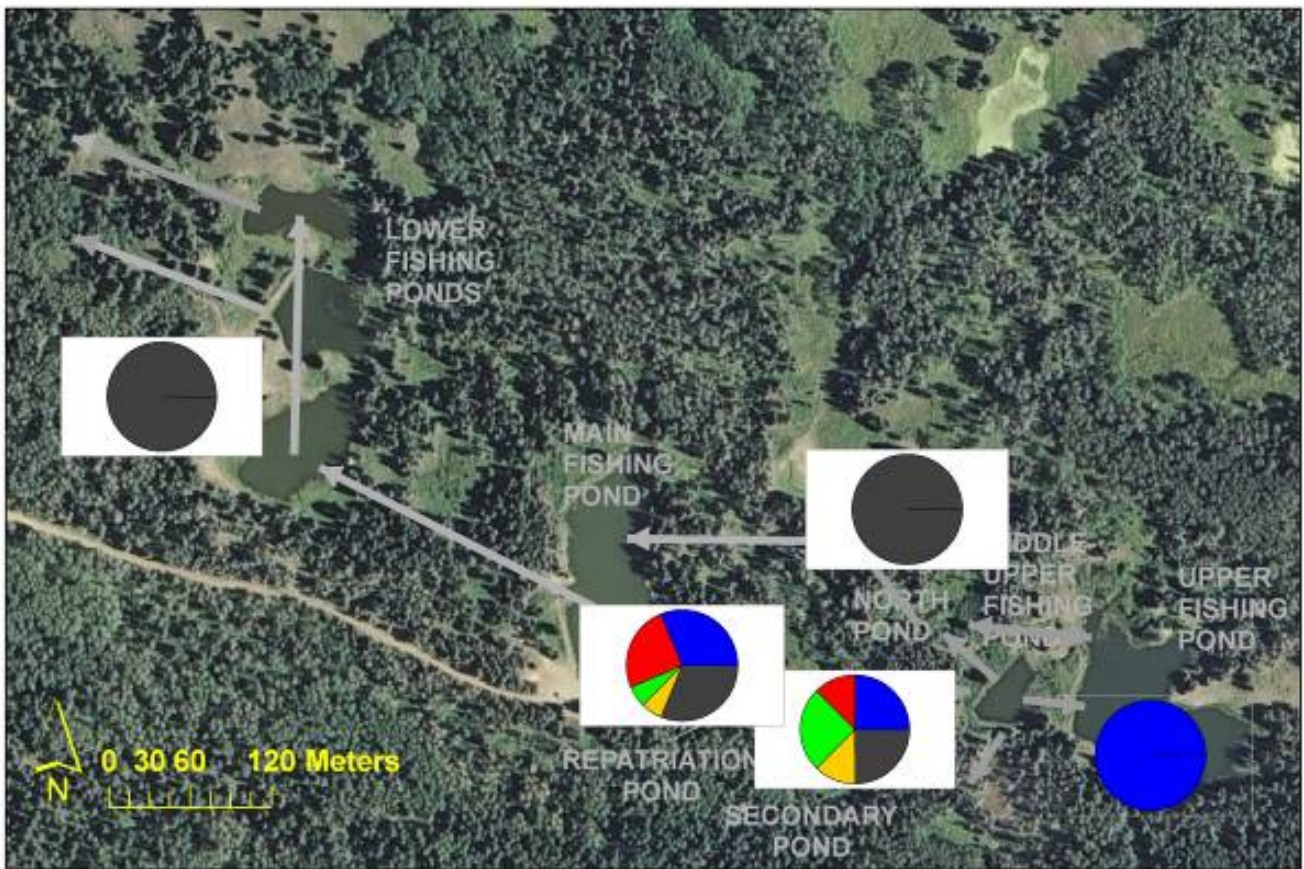


Figure 4. Bd signal detection across 2010 samples. Note that only one sample was taken each for Lower Fishing Ponds, North Pond, and Upper Fishing Pond, and chart is only a representation of detection of Bd. Chart colors as follows: Blue-Very Strongly positive or '+++', Red-Strongly Positive or '++', Green-Positive or '+', Yellow-Weakly Positive or 'W+', and Dark Gray-Negative or '-'.





**Figure 5. Habitat (other side of Upper Fishing Pond) where 2008 cohort toad found, 25 August 2010. Photo: L. Pierce, NMDGF.**



**Figure 6. 2008 cohort toad captured at Upper Fishing Pond, Trout Lakes, 25 August 2010. See also Figure 5 for image of habitat. Photo J. Stuart, NMDGF.**





**Figure 7. Dense vegetation growth in and around Repatriation Pond in late part of season, 25 August 2010. Photo: L. Pierce, NMDGF.**



**Figure 8. Second 2010 sub-cohort of tadpoles, NMDGF Los Ojos Hatchery. Coloration of water due to B-vitamins recently added (liquid form). Photo: L. Pierce, NMDGF.**



**Figure 9. Colorado Division of Wildlife vehicle used for transport of boreal toad tadpoles. Pictured, Tim Sintas, NMDGF-Los Ojos Hatchery, Elaine Davinroy, CO DOW-NASRF. Photo: L. Pierce, NMDGF.**

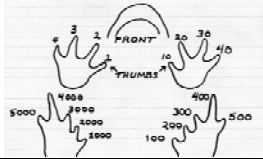
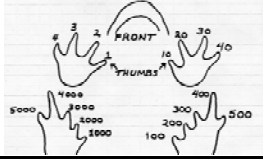
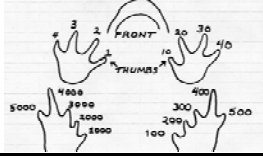
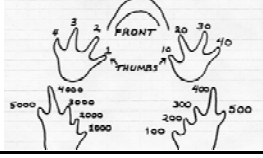
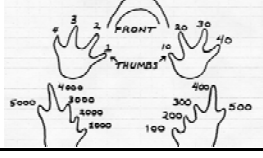
Date:		Observers:	
Start Time: AM PM		End Time: AM PM	
GPS Settings:			
Climate			
Air Temp:		Water Temp:	Wind:
Notes:			
Samples Collected			
Water	Chytrid	Toe	Other:
Egg Masses & Tadpoles			
# Egg masses:			
Tadpoles: <100 100-500 500-1000 1000-2000 >3000			
Notes:			
Toad Observations			
ID:	Age:	Sex: M F	
SVL:	Mark: Toe PIT Other:		
Recap? Y N	Notes:		
ID:	Age:	Sex: M F	
SVL:	Mark: Toe PIT Other:		
Recap? Y N	Notes:		
ID:	Age:	Sex: M F	
SVL:	Mark: Toe PIT Other:		
Recap? Y N	Notes:		
ID:	Age:	Sex: M F	
SVL:	Mark: Toe PIT Other:		
Recap? Y N	Notes:		
ID:	Age:	Sex: M F	
SVL:	Mark: Toe PIT Other:		
Recap? Y N	Notes:		
Notes:			
Egg Masses & Tadpoles			

Figure 10. Sample Field Sheet. Note marking scheme figure repeated on sheet.

## Other Species Observed

(\*-indicates observed in localities known also to have Boreal Toad; #-indicates observed through camera traps)

### A. Invertebrates

- a. Odonates (Dragonflies and Damselflies)
  - i. Northern Spreadwing, *Lestes disjunctus*\*
  - ii. Boreal Bluet, *Enallagma boreale*\*
  - iii. Taiga Bluet, *Coenagrion resolutum*\*
    - 1. County Record
  - iv. Paddle-tailed Darner, *Aeshna palmata*\*
  - v. Boreal Whiteface, *Leucorrhinia borealis*\*
  - vi. Four-Spotted Skimmer, *Libellula quadrimaculata*\*
  - vii. Black Meadowhawk, *Sympetrum danae*
  - viii. Cherry-faced Meadowhawk, *S. internum*\*
  - ix. Striped Meadowhawk, *S. pallipes*\*
- b. Butterflies
  - i. Mourning Cloak, *Nymphalis antiopa*
  - ii. Weidermeyer Admiral, *Limenitis weidermeyerii*

### B. Fish

- a. Fathead Minnow, *Pimephales promelas*\*

### C. Amphibians

- a. Northern leopard frog, *Rana (=Lithobates) pipiens*\*
- b. Chorus Frog, *Pseudacris maculata*\*

### D. Reptiles

- a. No reptiles observed in 2010

### E. Birds

- a. Mallard, *Anas platyrhynchos*\*
- b. Spotted Sandpiper, *Actitis macularia*
- c. Dusky Grouse, *Dendragopus obscurus*\*
- d. Turkey Vulture, *Cathartes aura*
- e. Red-tailed Hawk, *Buteo jamaicensis*
- f. Belted Kingfisher, *Ceryle alcyon*\*
- g. Northern Flicker, *Colaptes auratus*\*
- h. Downy Woodpecker, *Picoides pubescens*
- i. Steller's Jay, *Cyanocitta stelleri*
- j. Black-billed Magpie, *Picea hudsonia*
- k. American Crow, *Corvus brachyrhynchos*\*
- l. Common Raven, *C. corax*\*
- m. American Robin, *Turdus migratorius*
- n. Yellow-rumped Warbler, *Dendroica coronata*
- o. Violet-green Swallow, *Tachycineta thalassina*\*
- p. Chipping Sparrow, *Spizella passerina*
- q. Song Sparrow, *Melospiza melodia*

### F. Mammals

- a. Golden-mantled Ground Squirrel, *Spermophilus lateralis*\*

- b. Rock Squirrel, *S. variegatus*
- c. Least Chipmunk, *Tamias minimus*\*
- d. Red Squirrel, *Tamiasciurus hudsonicus*\*
- e. Abert's Squirrel, *Sciurus aberti*
- f. Vole, *Microtus* spp. \*
  - i. Likely either Long-tailed Vole, *M. longicaudus*, or Montane Vole, *M. montanus* or both
- g. Ermine, *Mustela erminea*\*#
  - i. Some potential this might be Long-tailed Weasel, *M. frenata*
- h. Cattle
- i. Elk, *Cervus elaphus*
- j. Mule Deer, *Odocoileus hemionus*\*#

### **Proposed Monitoring Protocol for 2011**

#### Mid to Late May.

Make an effort to get up into Trout Lakes, conduct haphazard search of release site area, looking for 2- and 1-year old toads. Search would be timed (number of toads observed/person-hours) and not intensive. Toads under 40 mm would be considered 1<sup>st</sup> year toads.

#### First or Second Week of June.

Overnight trip to Trout Lakes. Night time surveys for Boreal Toad and Northern Leopard Frog in particular throughout the area. Day time surveys for all species of amphibian, with emphasis on Boreal Toad. Searches to be timed, haphazard surveys. Set up 1 – 2 centralized stations where toads and other amphibians would be measured, toe-clipped (if necessary), given a PIT tag (if toad is over 50mm), swabbed for Bd, and their bellies photographed. Experienced herpetologists will be needed for this survey, as 2-year old toads apparently require much more effort to find, having been found in much denser vegetation than younger toads, plus they do not readily draw attention to themselves the way 1-year old toads and toadlets do.

Also do intensive searches of adjoining ponds in the area, up to and including flipping downed logs and rocks. The goal is to identify what ponds the toads are visiting, with the long-term goal of knowing where they are when they reach breeding age (2013).

#### Repeat monthly.

### **Research questions and hypotheses**

Suggestions for research to improve the capacity of the NM Boreal Toad Recovery Team to recover the species. For more information, contact Leland Pierce, NMDGF ([leland.pierce@state.nm.us](mailto:leland.pierce@state.nm.us), 505/476-8094).

Impact of fathead minnows on boreal toad eggs and very young larvae.

Observations suggest that fathead minnows can be present when boreal toad eggs are laid. The minnow is not prevalent in Colorado where boreal toads breed.

- **Do fathead minnows prey upon boreal toad eggs?**
- **Do fathead minnows prey upon boreal toad larvae?**
- **Do fathead minnows disturb boreal toad larvae?**
- **Are there differences in behavior between boreal toad larvae in the presence of fathead minnows vs. boreal toad larvae not in the presence of fathead minnows?**

Natural history observations of boreal toads in NM versus those in Colorado that provided the stock for the New Mexico repatriation.

- **Are growth rates similar?**
- **Is Gape Width a more reliable measurement of the size and age of toads than Snout-to-Vent length?**
- **What ecological features are associated with population genetic differentiation in Colorado populations (see Manier & Arnold 2006)?**
- **(Long-term) What ecological features are associated with population genetic differentiation in New Mexico populations?**

The repatriated population of boreal toads are confirmed to be dispersing throughout the Trout Lakes area. Based upon observations of 1- and 2-year old toads and toadlets. As the toads and toadlets disperse, they encounter differing landscape features, prey communities, predator communities, and other amphibians.

- **Do toads and toadlets use streams to disperse?**
- **Can nets be placed in streams to determine dispersal by toads?**
- **Do toadlets follow specific habitat features for dispersal, or do they disperse randomly from the pond?**
- **What biophysical features are important for the toads and toadlets (such as humidity levels in dense grasses versus open areas)?**
- **As toadlets disperse how do they use retreats available to them, particularly when away from ponds, streams, and marshes?**
- **Is there a correlation between available retreats and survival of the toadlets to the following year?**
- **What, if any measureable habitat differences exist between age classes of toads?**
- **Are there physical barriers to dispersal?**
- **How does community assemblages (prey, predator, amphibian) vary across the many ponds of Trout Lakes?**
- **Does Bd intensity vary across ponds?**
- **Can other organisms, such as dragonflies and diving beetles be sampled for Bd?**
- **Does the dragonfly larvae community vary across ponds within the system both spatially and temporally?**

- **Are certain dragonfly larvae and dragonfly larvae communities more of a threat to boreal toad larvae than others?**

Modeling. The observation of the boreal whiteface dragonfly, well outside of its given range, as well as the potential presence of American marten and confirmed presence of northern leopard frog suggests the system at Trout Lakes is an important site for biological diversity in northern New Mexico. Dispersing toads and toadlets are likely encountering differing communities, communities assembled from communities of species in surrounding regions.

- **How does the biological diversity at Trout Lakes compare to other local communities (such as Canjilon Lakes, Hopewell Lake, Lagunitas Lakes, Cumbres region, Cruces Basin) in terms of species composition, population density and other indices of biological diversity?**
- **Are boreal toads more likely to have persistent populations in sites with higher biological diversity? Lower?**
- **Can the theories of Island Biogeography be applied at the local, Trout Lakes level, as well as the regional level, to model how communities locally and regionally, including Bd, are distributed across the landscape?**

Citation.

Manier, M. K. and S. J. Arnold. 2006. Ecological correlates of population genetic structure: a comparative approach using a vertebrate metacommunity. *Proceedings of the Royal Society B* 273: 3001-3009.