Instruction Manual
and
Frog Survey Protocols

for

Region 1 National Wildlife Refuges, East-side Zone

(Great Basin and Great Northern LCCs).

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Introduction and Document Organization

This Instruction Manual and accompanying protocols are designed to provide guidance to stations wishing to conduct frog surveys. Although the primary focus of this document is on surveys designed for baseline inventory, the methods herein can also be used to obtain long-term trend information ("monitoring").

The document was specifically created for National Wildlife Refuges in the East-side Zone of Region 1 of the USFWS: eastern Oregon, eastern Washington, and Idaho. Information regarding which species to expect in a survey area, survey timing, and breeding chronology are specific to this project zone. Species-specific protocols are provided for three native species of frog and a native toad (Appendix 4 through 7), but a general survey protocol (Appendix 3), useful for finding other frog and toad species, is provided as well.

There is a wealth of information in this document, but it is designed in a "modular" fashion, allowing readers to jump straight to sections of particular interest. The document begins with an Instruction Manual, but contains species-specific background information and survey protocols, as well as a general survey protocol, as appendices. It is the author's intent that the survey protocols be able to stand alone. They have enough detail to allow anyone to conduct a survey by following the instructions within each one. The background information included for each target species is intended to help surveyors understand the animal they are looking for, and make them more effective. The survey protocols can be used without this background information. It is provided for the same reason as the Instruction Manual – as a convenient source of additional information.

The Instruction Manual contains detailed information about amphibian surveys, including: rationale and timing of different survey methods, equipment, frog identification, safe handling techniques, creating voucher photographs and reference collections. Readers are advised to visit some or all of the following sections, based on specific need.

Information in the Instruction Manual is organized in the following fashion:

Section 1. **Introduction:** Describes the project zone, lists common and scientific names of amphibians in the zone, and defines terms used in the report.

Section 2. **Surveys**

2a. *Conducting Surveys:* Recommendations of timing and target life stages for surveys, customized for the project zone. Includes discussion on detectability and breeding chronology, as well as the rationale for selecting timing, location, and life stages to target during surveys.

2b. *Breeding Surveys:* Methods and timing of surveys to detect breeding frogs/toads and egg masses.

2c. *Tadpole Surveys:* Methods and timing of surveys to detect larvae (tadpoles).

2d. *Frog Surveys:* Methods and timing of surveys to detect adult and newly transformed frogs and toads.

Section 3. Data and Equipment

3a. *Survey Data:* Defines research objectives, which data are important, and how to collect data in a field setting.

3b. *Organization and Interpretation of Data*: Methods for organizing data and determining what they mean.

3c. *Survey Equipment:* Recommended equipment for amphibian surveys.

3d. *Sources of Equipment*: Provides a list of suppliers for specialized equipment.

Section 4: Techniques

4a. *Identification:* Tips and recommended resources to assist with identification. Includes photographs and discussion of diagnostic characteristics.

4b. *Capture and Handling:* Tips and recommendations for safe handling of amphibians.

4c. *Containers and Transport:* Tips and recommendations for proper transportation of live amphibian specimens.

4d. *Photography:* Tips and recommendations for taking voucher quality photographs of amphibians.

4e. *Raising Tadpoles:* Tips and recommendations for raising tadpoles to assist with species identification.

4f. *Collection and Preservation:* Tips and recommendations for collection and preservation of specimens for a reference or research collection.

4g. *Disinfection:* Instructions for proper disinfection of survey equipment.

Section 5: References

Section 6: Appendices

Appendix 1: Introduction to survey protocols and explanation of methods used.

Appendix 2: Occurrence and detectability of East-side Zone frog species.

Appendix 3: General survey protocol for frogs and toads within the project zone.

Appendix 4: Oregon spotted frog – a) species description and survey methods; b) survey protocol

Appendix 5: Columbia spotted frog – a) species description and survey methods; b) survey protocol

Appendix 6: Northern leopard frog – a) species description and survey methods; b) survey protocol

Appendix 7: Western toad – a) species description and survey methods; b) survey protocol

Appendix 8: Data sheets

Photo Credits

Unless otherwise indicated, all photographs and illustrations in this document are the work of the author, and may be reproduced. All specimens illustrated are courtesy of the author, with the exception of three leopard frogs (*Rana pipiens* – see Appendix 5), which were captured and photographed by Gary Nafis. Thanks Gary!

Reference

This report is the property of the United States of America, and may be referenced as follows:

Rombough, C. 2012. Instruction manual and frog survey protocols for Region 1 National Wildlife Refuges: East-side Zone. Report to the United States Fish and Wildlife Service, Region 1 Inventory and Monitoring Program, Vancouver, WA.

Names and Terms

Names

The use of scientific names (binomial nomenclature) helps reduce confusion, particularly for species with multiple common names. Scientific names also reflect a species' relationship to others. Because of this, they are subject to change as science gathers more information.

A list of the most current scientific and common names for North American amphibians and reptiles is published by the Society for the Study of Amphibians and Reptiles. This list is now available online, at: http://www.ssarherps.org/pages/comm_names/Index.php. In the most recent edition of this list, the names of a number of amphibian species have been changed. The most current names for the species listed in this report are thus:

Great Basin spadefoot, *Spea intermontana*
Western toad, *Anaxyrus boreas*
Woodhouse's toad, *Anaxyrus woodhousii*
Northern red-legged frog, *Rana aurora*
Columbia spotted frog, *Rana luteiventris*
Oregon spotted frog, *Rana pretiosa*
Wood frog, *Rana sylvatica*
Northern leopard frog, *Lithobates pipiens*
American bullfrog, *Lithobates catesbeianus*
Northern Pacific treefrog, *Pseudacris regilla*
Boreal chorus frog, *Pseudacris maculata*

However, these names are not yet in wide use, since existing publications have not yet been updated (including the most widely used reference to western North American amphibians: R.C. Stebbins' Field Guide to Western Reptiles and Amphibians, 3rd Edition).

My solution to this situation is to:

1) inform the reader of the taxonomic changes, and

2) follow the existing usage in this report, for practical purposes.

Terms

Some terms used in this report require explanation:

1. **Adult:** in herpetological usage, "adult" may refer to any frog or toad that has transformed and is no longer a tadpole (including juvenile frogs) OR a sexually mature frog (*i.e.*, not a juvenile). In this report, both uses are employed. Context will indicate which is appropriate.

2. **Amplexus:** the grip by which a male frog holds a female during mating and fertilization of eggs.

3. **Breeding:** as used here, indicates mating activity (calling, amplexus, *etc*.) that results in the deposition of eggs.

4. **Detectability:** refers to how easily a frog can be found. It is used interchangeably with "**visibility**" in this report.

5. **Larva:** the immature, free-swimming stage of a frog. Used interchangeably with "**tadpole**" in this report.

6. **Metamorph:** An animal which is in the process of transforming from a larva (or tadpole) to a frog (or adult).

   A metamorph is often defined as a frog which has one or more front limbs AND a tail. Once the tail is completely absorbed, the animal has completed transformation and is considered a frog (or adult).

A spotted frog **metamorph**

7. **Metamorphosis:** the process of physical transformation by which a larva (or tadpole) becomes a frog.

8. **Permanent:** when used to describe a water body, refers to a body of water that does not dry up annually. In other words, water that is present year-round.

9. **Spawning:** refers to the actual deposition (laying) of eggs, unless otherwise indicated.

10. **Survey area:** refers to either: 1) a general location, or 2) to the specific geographic region covered by this report: the Great Basin and Great Northern LCC's. Context will indicate use.

11. **Tadpole:** the immature, free-swimming stage of a frog. Used interchangeably with "**larva**" in this report.

12. **Temporary:** when used to describe a water body, refers to a body of water that dries up at least once a year. In other words, water that is not present year-round.

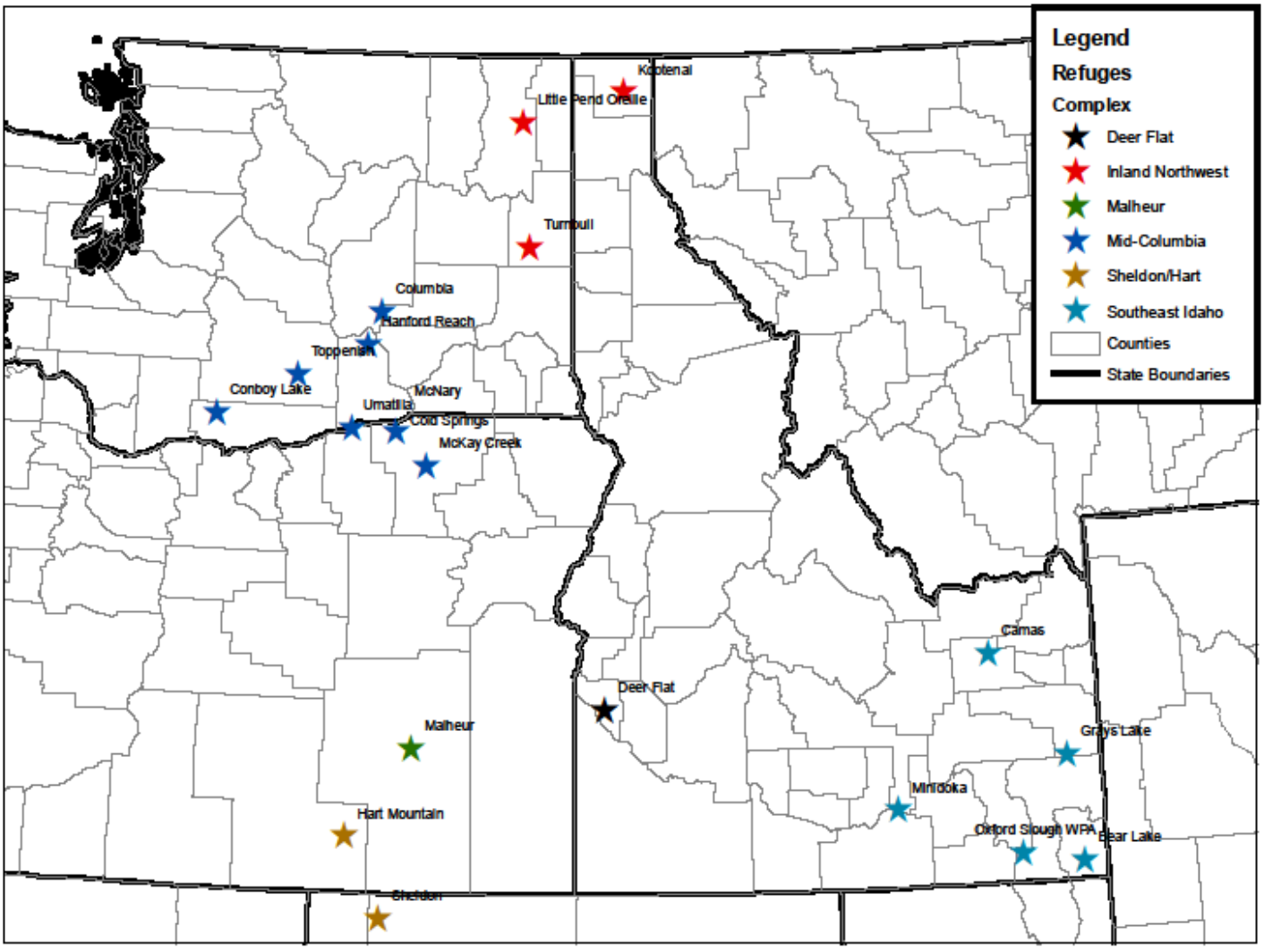
13. **Visibility:** refers to how easily a frog can be found. It is used interchangeably with "**detectability**" in this report.

Project Zone

This report was developed for National Wildlife Refuges in the East-side Zone of Region 1 (Figure 1). The Eastside Zone consists of refuges in Region 1, east of the Cascade Mountains. The geographic area overlaps with the Great Northern and Great Basin Landscape Conservation Cooperatives (LCCs). Recommended timing and survey methods included in this report were developed for this geographic area, referred to as the "project zone".

Optimal timing of amphibian surveys varies by species, location, and local climatic conditions. Recommended timing and survey methods described herein were developed for this geographic area, and may not be appropriate elsewhere.

Figure 1. Location of National Wildlife Refuges within the East-side Zone of Region 1, US Fish and Wildlife Service.



Section 2: Surveys

2a. Conducting Surveys

Introduction

This chapter tells you how to conduct inventory surveys for frogs.

Inventory surveys are the most fundamental type of biological research. Their purpose is to identify which species are present in a particular area. For purposes of this report, inventory surveys are broken into two separate types: 1) ***general*** and 2) ***species-specific***.

1. **General inventory surveys**. The goal of these surveys is to determine which species occur in a given area. They are conducted under conditions which are favorable for detecting the greatest number of species. They do not target any particular form, but record species opportunistically, as they are encountered. The majority of this chapter describes conditions under which general surveys will be most successful.

2. **Species-specific surveys**. The goal of these surveys is to determine the occurrence and/or distribution of a particular species. They are conducted under conditions most favorable for detection of the target species. Finding a particular species in a previously unexplored area often requires more preparation than simply looking for whatever you can find. Therefore, specific instructions for finding target species (spotted and leopard frogs, and western toads) are included below.

Getting started: Detectability

General surveys: The first step in conducting a general inventory is to identify the habitat and survey conditions under which you will be most successful. The best conditions for finding eggs, tadpoles, and adult frogs are described in the following sections.

Species-specific surveys: When surveying an area where a species has not previously been recorded, the first step is to determine if the species is present. Once this has been accomplished, future surveys can be conducted to determine its distribution, life history, habitat use, *etc*. This sounds basic, but many survey projects doom themselves to failure by trying to do everything at once.

The most efficient way to perform inventory surveys is to focus on a species' most detectable life stage. The most detectable life stage is the one which a surveyor can find the most quickly and reliably, with the highest consistency and least room for error. It is dependent on two things:

1) the species' life history, and
2) the survey area.

Life history

Each frog species has individual behavioral and physiological traits which determine what its most detectable life stage will be. For example, the most detectable life stage of a spotted frog (*Rana luteiventris* or *R. pretiosa*) is the adult (or juvenile) frog. This is because, compared

to the eggs and tadpoles, frogs are present over the largest area and are visible for the longest period of time each year (Table 1).

Table 1. Relative detectability of spotted frog (*Rana luteiventris, Rana pretiosa*) life stages

Life Stage	Time Present[1]	Ease of Detection[2]
Egg Mass	2 - 4 weeks[3]	Difficult (in new area): often laid in specific, relatively small area
Tadpole/Larva	6 - 9 weeks[3]	Difficult: though abundant, can be hard to find – often clustered near breeding area
Frog	15 – 20 weeks[3]	Easy: Easiest to find following metamorphosis, during summer low water. May be difficult to find at some times (*e.g.*, cold weather, just after breeding).

[1]Amount of time visible during the year [2]In a new (previously unknown) area [3]On average

In contrast to the spotted frogs, the most detectable life stage of the Northern red-legged frog (*Rana aurora*) are its eggs, and western toads are most easily found as tadpoles. Table 2, at the end of this section, lists the most detectable life stages of several frog and toad species within the survey area.

How do you know which life stage to look for? If you are not familiar with a species, a good field guide will tell you. Two good ones for this area are: R.C. Stebbins' Western Reptiles and Amphibians (2003), and Corkran and Thoms' Amphibians of Oregon,Washington, and British Columbia (1996). In addition, **Appendix 2** provides a table of relative detectability by life stage, for frog species within the project zone.

Location and timing

Once you know *what* to look for, it is important to know *where* and *when* to look. The location of your survey makes a big difference, even when looking for the most detectable life stage. This is because many frogs use different habitats at different times of the year.

For example: Pacific tree frogs (*Hyla regilla*) have a loud and very distinctive call, and the males will call vigorously from breeding sites during the spring mating season, often for a fairly long period of time: up to several months in some areas. The rest of the year, adults are hard to find, since they move far from water and blend in well with the color of trees and brush. In contrast, the call of the Oregon spotted frog (*Rana pretiosa*) is given underwater, and is so quiet that it can hardly be heard, even when frogs are very close. In addition, the breeding season is very short – at some sites, males call for less than two weeks! However, unlike the tree frog, spotted frogs are very aquatic, and stay close to water year-round, making them easy to find in an occupied site.

Therefore, the best time and place to find adult Pacific tree frogs is during the breeding season, at breeding sites. The best time and place to find adult Oregon spotted frogs is after the breeding season, in active-season habitat.

Survey Area

When deciding which life stage to target, the last thing to consider is the size and accessibility of your particular survey area. For sites which are small and easily surveyed, it is less important which life stage you look for, since you can come back and search the entire site

again. For large sites, your choice of life stage may be the deciding factor in your success or failure at finding a particular species.

Table 2. Most detectable life stages of some frog and toad species in the project zone

Species	Small Site	Method/Reason	Large Site	Method/Reason
Oregon spotted frog (*Rana pretiosa*)	Visual survey for frogs	Frogs very aquatic, highly detectable – breeding season short	Visual survey for frogs at selected sites (within larger survey area)	Generally stay close to water; adults quiet, short breeding season
Columbia spotted frog (*Rana luteiventris*)	Visual survey for frogs	As with *R. pretiosa*	Visual survey at selected sites	As with *R. pretiosa*
Northern leopard frog (*Rana pipiens*)	Visual survey for frogs, maybe call surveys if site is very small.	Egg masses, larvae difficult to detect – but frogs more vocal than preceding species.	Visual survey for frogs at selected sites	Frogs are most visible and longest-present life stage
Western toad (*Bufo boreas*)	Tadpole and juvenile surveys – focus on good habitat	Tadpoles school, cover large area, are easy to see; adults hard to find	Tadpole, juvenile surveys of selected sites, road-hunting and checking lights at night	Tadpoles and juveniles are most visible life stages; adult detections will give direction to suitable habitat
Pacific tree frog (*Hyla regilla*)	Call surveys, tadpole surveys	Calls loud, over prolonged season (usually); tadpoles fast-growing, abundant over long period	Call surveys, tadpole surveys	Calls loud; tadpoles fast-growing, but usually abundant, and a surveyor can dip-net ponds over a large or remote area

Examples of using the most detectable life stage for inventory surveys

1. Suppose you have a very large refuge which you want to survey for spotted frogs (*Rana luteiventris*). In particular, you want to know where they breed. Over a large area, the most efficient approach is to look for adult frogs, which are active for the entire spring and summer. So, you conduct surveys for frogs. In the places where you find them, you return the following spring and survey the best breeding habitat. Recording the dates when you find eggs will allow you to observe breeding in following years, for life history research or population monitoring.

2. During a nighttime drive, you find a Woodhouse's toad (*Bufo woodhousii*) on the road. While this observation confirms their presence, you want to know where they breed. You use a map to locate aquatic habitats within a mile or so of your find, and pick out those that have water during the appropriate time of year (April through June). Since breeding is short, and eggs hatch quickly, you survey your sites for the presence of larvae or toadlets. By doing this, your survey interval can be increased to 2-3 weeks at each site (as opposed to every few days). Once larvae or juveniles are found at a site, it can be checked earlier the following year, to determine the exact time of breeding.

3. One summer, you constantly find Pacific tree frogs (*Hyla regilla*) around your office. You would like to know where they are breeding, but since they can travel a long way from water, you can't tell from the frogs alone. You look for the nearest bodies of water, and the following spring, you drive past them at night. Sure enough, one night you hear a loud chorus coming from a nearby pond. Returning the following morning, you find freshly laid tree frog eggs in the shallows.

2b. Breeding Surveys

Introduction

Why are breeding surveys done? Typically, they are done for one of two reasons: either 1) as a means of monitoring population size (e.g., via egg mass surveys), or 2) to detect species which are most easily found this way (species which call loudly or have very visible egg masses). Eggs of most frogs can be found using a standard visual survey protocol. However, over the project zone treated here (the arid intermountain west), surveys conducted during the best time for finding adult frogs are often too late to find eggs of most species. Therefore, surveys targeting eggs or breeding frogs usually have to be timed specifically for that purpose.

Timing. Across the project zone, the first frogs to breed are usually the ranid (true) frogs: *Rana pretiosa, Rana luteiventris, Rana pipiens*, and *Rana sylvatica*. (*Rana pipiens* is often several weeks later than the others.) The earliest ranid frogs will begin breeding as soon as ice melts from the surface of a breeding area.

Tree frogs and chorus frogs begin breeding slightly later than the earliest true frogs, as water warms up slightly. At a given site, they may begin laying eggs at the same time as the true frogs, or might not start until several weeks later.

Toads prefer the warmest water, and often breed the latest: in some areas, breeding may be delayed until run-off from snow melt or rain storms fill breeding areas. There can be considerable variation in breeding time at a given elevation because of this.

Table 3. General timing of frog and toad breeding across the project zone

Weather	Month	Spotted frogs, Wood frog	Leopard Frog	Tree frog / Chorus frog	Toads
Ice-out at low elevations	**January**	Low elevations			
	February	↓		Low elevations, sites with temporary water	
	March	↓ ---------- Higher elevations	Low elevations	↓	Low elevations
Ice-out at higher elevations, water warms at lower elevations	**April**	↓	↓	↓	↓
	May	↓	↓	↓ ---------- Higher elevations	↓
Water warms at higher elevations, snowmelt run-off appears at lower elevations	**June**		↓ ---------- Higher elevations	↓	↓ ---------- Higher elevations; low elevations following snowmelt, rain storms
	July		↓	↓	↓

Planning a breeding survey

Planning general surveys:

To conduct a general breeding survey at a new location, the best method is to pick a survey site and be prepared to start visiting it when the ice first melts off in the spring. An early visit makes sure that you don't miss breeding, but also gives you an opportunity to scout conditions at the site and thus be better prepared. You can also plan visits based on the timing of breeding (by any species) at nearby sites.

Planning species-specific surveys:

So, if the time of breeding for a given species is very specific, how do you determine when to look for eggs (or breeding adults) in an area that you have never visited before? The easiest way is to predict breeding time, using existing information for your region. The following section demonstrates how to do this.

Step 1: Gather information

The first step in planning species-specific breeding surveys is to gather information for your area. Field guides are good places to start. Two good ones for the survey area are Stebbins (2003) and Nussbaum *et al.* (1983). Next, narrow down your search window. One way to do this is by checking for published papers and agency reports. If you don't have access to a searchable literature database, Google Scholar is a surprisingly good resource for this type of data. Other good sources of information include herpetologists, refuge maintenance staff, local zoology professors, and sometimes local biologists. As you collect information, organize it in a way that it will be most informative; grouping by physiographic province, elevation, and then by drainage basin or habitat type usually works well.

What about water temperature?
Water temperature at a site influences the time of breeding for many frogs. However, it is typically not very useful for managers scheduling surveys, since temperature within a water body can vary dramatically by location and time of day, and it is the temperature at the exact breeding site, when frogs are present, that is of most importance. Trying to predict the exact location of breeding, and then tracking temperature is impractical over large or unknown areas.

The following tables illustrate this process for four species of frogs, using data collected within the survey area, or for similar elevations and regions. (Sources are listed in the "References" section.)

Dates of Breeding – *Rana pretiosa*			
Date	**State/ Province**	**Elevation**	**Reference**
Feb. – March	WA	Conboy Lake NWR	C. Rombough, *pers. obs.*
March	WA	Puget Sound	Dickerson 1906
Feb. – March	WA	Low elevations	Leonard et. al. 1993
May – June	WA	High elevations	Leonard et. al. 1993
Jan. – July	Western US		Stebbins 2003
March	British Columbia	SW BC	Nussbaum et. al. 1983
Feb. – March	British Columbia	SW BC (Fraser River Valley)	Matsuda et al. 2006
Feb. – March	WA	"Lower elevations"	Jones et al. 2005
March – April	OR, WA	"Higher elevations" (Cascade Mountains)	Jones et al. 2005

Dates of Breeding – *Rana luteiventris*			
Date	**State/ Province**	**Elevation**	**Reference**
March-April		Across range	Wright and Wright 1949
Mid-March – early April	WA	Vicinity of Pullman	Svihla 1935
March-June	MT	Low-High	Werner et al. 2004
Feb.-July	Western US		Stebbins 2003
March	UT		Stebbins 2003
May-June	WY		Stebbins 2003
June	OR	Mountain lake (NE OR)	Nussbaum et al. 1983
May-June	WY	7,800 ft. / 2378 m	Turner 1958
April-May	British Columbia	"Southern interior B.C."	Matsuda et al. 2006
June	British Columbia	Northern B.C., "higher elevations"	Matsuda et al. 2006
March-April	WA	Columbia Basin	Jones et al. 2005
May-June	NW states	"High elevations"	Jones et al. 2005
April	OR	Malheur NWR	Rombough and Engler 2010
May	OR	4789 ft. / 1,460 m	C. Tait, *unpubl. data*, (in Pearl et al. 2010)
April	OR	4560 ft. / 1,390 m	M. Brown, *unpubl. data*, (in Pearl et al. 2010)
March-June	OR	3024 ft. / 922 m (March site) – 7281 ft. / 2220 m (June site)	Bull 2005
April	ID	Rock Creek, Owyhee Co.	Engle and Munger 2003

Dates of Breeding – *Rana pipiens*			
Date	**State/ Province**	**Elevation**	**Reference**
April – May	Eastern US		Wright and Wright 1949
March – April	MD, NC		Dickerson 1906
March – April	CO	< 5,500 ft. / 1677 m	Hammerson 1986
May – June	CO	6,680-7,760 ft. / 2037-2366 m	Corn 1981
April – May	MT		Werner et al. 2004
March – June	Western US		Stebbins 2003
March – April			Nussbaum et al. 1983
April – May	British Columbia		Matsuda et al. 2006
April	Western US		Jones et al. 2005
April – May	WA	Potholes Reservior	Germaine and Hays 2009
April – June	Alberta		Wershler 1992 (in Wagner 1997)
April – June	ID		Linder and Fichter 1977
March - May	WY		Corn and Livo 1989

Dates of Breeding – *Bufo boreas*			
Date	**State**	**Elevation**	**Reference**
March	CA (central)		Pickwell 1947
May – July	MT	≤9,220 ft / 2811 m (all)	Werner et al. 2004
Feb. – April	WA	Low elevations W. of Cascade Mts.	Leonard et al. 1993
May – July	WA	Higher elevations in Cascade Mts.	Leonard et al. 1993
June – July	WA, OR	NE OR and SE WA	Leonard et al. 1993
May – June	CO	Boulder Co.	Campbell 1972
Jan. – July	Western US		Stebbins 2003
May – June	OR	5,183 ft. / 1580 m (Diamond Lake)	Hayes 1997, Hayes and Price 2007, Hayes and Rombough 2008, Rombough 2009
< May	OR	Wenaha WMA	St. John 1982
Jan. – Feb.	OR, WA	Coastal areas	Nussbaum et al. 1983
≤ July	OR, WA	Higher montane areas	Nussbaum et al. 1983
July	OR	Snake River canyon	Nussbaum et al. 1983
June	OR	7478 ft. / 2,280 m	Nussbaum et al. 1983
January – July	NW states		Jones et al. 2005
May	ID	Approx. 5,000 ft. / 1524 m	Llewellyn and Petersen 1998
June - July	ID	800-900 ft. / 244-274 m	Llewellyn and Petersen 1998

Predicted breeding by refuge

Table 4 summarizes the data listed above, and uses it to predict breeding times for each species at a given refuge. The times listed represent estimates of when breeding would begin, *if* the species was present on the refuge. Remember that estimates are based on elevation. Local hydrology, habitat and climate will further influence breeding time, but this estimate provides a good starting point.

Table 4. Predicted breeding time of frogs in the project zone, based on available information
NP = Not present, based on available data. Occurrence data for refuges is provided by the USFWS.

Complex	Refuge	Elevation (ft)	*Rana pretiosa*	*Rana luteiventris*	*Rana pipiens*	*Bufo boreas*
Mid-Columbia	Conboy Lake	1,800	March	NP	NP	April-May
	Toppenish	700-900	NP	March	April	April-May
	Hanford Reach	500	NP	March	April	April-May
	Columbia	500-1,000	NP	March	April	April-May
	Umatilla	290	NP	NP	April	April-May
	McNary	360	NP	NP	April	April-May
	Cold Springs	620	NP	March	April	April-May
	McKay Creek	1,300	NP	March	April	April-May
Inland Northwest	Turnbull	2,000-2,400	NP	March-April	NP	May
	Little Pend Oreille	2,000-3,000	NP	March-April	May	May
	Kootenai	1,790	NP	March-April	NP	April-May
Deer Flat	Deer Flat	2,500	NP	April	April-May	May
Malheur	Malheur	4,100	NP	April	April-May	May-June
Hart / Sheldon	Hart Mtn.	5,000-7,000	NP	April	NP	May
	Sheldon	5,500-	NP	April	NP	May
SE Idaho	Camas	4,800	NP	NP	April-May	May
	Gray's Lake	6,400	NP	NP	April-May	May-June
	Minidoka	4,200	NP	NP	April-May	May
	Oxford Slough	4,700	NP	NP	April-May	May
	Bear Lake	5,900	NP	NP	April-May	May-June

Survey methods

Site selection

Survey sites are chosen for a number of reasons. Typically, site selection is directly related to the question of interest. For example, survey sites may be places where frogs were found previously, historic sites, likely looking habitat, future project areas, *etc*.

Location

General surveys:

To find frog eggs, walk slowly and quietly through the shallow water of your site. Most frog species covered by this report will lay their eggs in less than 2 feet of water, so concentrate your effort on these shallow areas. Walking slowly reduces water disturbance and increases your chance of seeing eggs (polarized lenses help too). Walking quietly increases your chances of hearing frogs call, especially those species that call quietly and from underwater (*e.g.*, spotted frogs) – helping you know where to look.

Pay special attention to certain areas: north (=south-facing) shorelines, and areas near habitat where adult frogs or toads may spend the winter (deep water, moving water such as stream channels or springs, and woods are all types of winter habitat). Also look in areas with patches of partly-submerged weeds and quiet, sunny inlets.

At one lake in Oregon's Cascade Mountains (5,000 feet in elevation), Cascades frogs (*Rana cascadae*) breed as the ice melts off the water's surface. Though none are visible when the Cascade frogs begin, western toads breed in the same place 1.5 – 2 weeks later. At the same time as the toads, Pacific tree frogs begin breeding and continue to do so for the next several weeks.

Don't forget that different species of frogs will breed in the same area, at different times – so even if you find eggs of one species, you may want to come back and look again.

Species-specific:

To target a particular species, use information on the species' breeding habitat preferences to identify the area where breeding is most likely to occur. Then survey this area repeatedly* over a time period that extends from: *before* the species is expected to start breeding to *after* the breeding period is expected to conclude. This is a good job for interns or techs.

*Survey intervals should be shorter than the minimum time period it takes for eggs to hatch (i.e. < laying – hatching), which of course will vary by species.

Time of day and weather

The time of day when surveys are conducted is important, since it will affect visibility, and hence your success. Because egg masses are located at or below the surface of the water, choose weather conditions that maximize light penetration. The best survey conditions are during still (calm) weather, from late morning to early afternoon, on a day that is clear or has high overcast. Obviously, it is not always realistic to time your surveys based on the hope of nice weather, but ***here's what you should try to avoid:***

1. ***Wind***. Even a light breeze can cause enough rippling on the water's surface to make detection impossible. If there's any sort of chop (as on big water bodies), the situation is beyond repair. Call it off before you end up squashing more egg masses than you see. In many Great Basin and intermountain areas, wind increases dramatically in late afternoon, so you may want to plan surveys to be a morning activity.

2. ***Rain*** or ***Snow***. Same as wind. Precipitation causes surface disturbance that makes it difficult to see under the water. Informal experiments that the author has conducted suggest that even polarized lenses are of limited use under the types of conditions (overcast and windy) that accompany rain and/or snow during egg mass surveys. If the storm is extensive, it's time to call it off for the day.

3. ***Early*** and ***Late***. Avoid periods when the sun is at a low angle to the surface of the water, such as early morning and late afternoon. During these times, light penetration is low and reflectivity is high – and visibility is very poor. Even when the sky is clear and the amount of ambient light is high, it is very difficult to see into the water with accuracy. Although it is tempting to begin early (or stay late) to "get more done", it is much better (and more accurate) to make the most of a shorter period of good conditions.

During periods of low light, the water's surface is very reflective, and egg masses are difficult to see.

2c. Tadpole Surveys

Surveys may be conducted specifically for tadpoles, or performed as part of visual surveys for adult frogs and toads. In the case of the former method (surveys targeting tadpoles), a few tips apply:

Location

The best places to find tadpoles are in the immediate vicinity of known breeding sites. If this is not possible, surveys should target shallow margins of survey areas. Pay special attention to shallows which receive a lot of sunlight, such as those located along the north (=south-facing) shoreline of a water body. Special attention should also be given to the following:

- Sheltered/protected areas, such as a small bay of a large lake
- Shallows bordering stands of woods or brush
- Shallows with extensive growth of submerged or emergent (preferred) aquatic vegetation
- Slow margins or backwaters of streams – especially weedy margins
- Slow, weedy irrigation or road ditches
- Farm ponds or stock tanks – especially weedy margins

Timing. Two major factors should be considered: time of year and time of day.

Time of year

With few exceptions, frog larvae are very hard to detect immediately after they hatch from their eggs. This is because they are typically very small, not very mobile, and clustered in a small area (the immediate vicinity of the egg mass). As tadpoles age, they grow quickly to a more detectable size (up to 4" for large spotted and leopard frog tadpoles), and often gather in shallow water, making them easier to see. Following transformation, no tadpoles are left in the water to find.

Therefore, there is a period of time following breeding when tadpoles are easiest to find. For most of the species in the survey area covered by this report, this period is roughly a month, beginning about 3 weeks after breeding occurs at a given site. (Remember that this estimate will vary as a result of weather, water temperature, elevation, *etc*.)

Newly hatched tadpoles are very small.

Time of day

The tadpoles of most frogs within the survey area are generally diurnal, so the best time to find them is during daytime surveys, when visibility is good. In addition, tadpoles, which can move (and hide) are very difficult to see in dark water. Daily timing of surveys is therefore about the same as surveys for eggs (late morning – early afternoon).

Depending on weather conditions and the age and size of the larvae involved, tadpoles of some frog species will gather in shallow water during the morning hours, since the

shallows warm most quickly. A careful approach from the bank may find them in these areas. (This will obviously vary by species and habitat, but it is a good general trait to help you find larvae more easily.)

For example, in still waters which warm up quickly (marshes, broad shorelines of large lakes, cattle ponds, *etc*.), the midday and afternoon temperatures in shallow margins may be too warm for tadpoles, and they will seek shelter in deeper water, patches of weeds, or beneath cover on the bottom, and thus be harder to find. In cooler water, such as along snowmelt-fed rivers, springs, or deep lakes, larvae may remain clustered along shallow margins through the heat of midday.

Sometimes, disturbance from people or predators may force normally day-active larvae into hiding. In one interesting case, I found that frog tadpoles in the shallows of a large river would go into hiding during the daytime, in response to violent shoreline waves created by many ski boats. When boating activity died down, the tadpoles emerged from their hiding places to feed along the bottom.

As with egg mass surveys, sunny weather is the best time to look for tadpoles, both because of visibility and tadpole activity. When possible, try to survey during fair weather, and avoid overcast and stormy weather, since tadpoles are harder to see and may also be inactive (=hiding) during these times.

Methods

As with egg mass surveys, tadpole surveys can be done by simply walking or wading through suitable habitat and looking for larvae. However, unlike eggs, tadpoles are wary, and will flee a surveyor's approach. You will have greatest success if you learn to walk slowly and quietly. Stay out of the water whenever possible (like when simply covering distance to the next good spot). Approach likely-looking areas with caution. Stop and take a minute or two to stand still and look at an area before charging in with your dip net. You might see tadpoles that had fled upon your initial approach emerge from hiding and swim out where you can see them.

Besides running from you, the other thing tadpoles can do that eggs can't is hide from you! Therefore, simply walking through an area and looking for tadpoles usually isn't enough. Even if you are extremely stealthy, you can dramatically increase your success rate by searching cover where tadpoles hide. Here, a dip net is your most useful tool:

- Holding the net at a low angle, scoop rapidly through patches of submerged weeds or other flexible cover. (Holding a net at a low angle when scooping both increases your speed and reduces strain on the net head, making it last longer.)
- Flip (or kick) over rocks and logs on the bottom and net larvae as they flee.
- Flush tadpoles from thick or sturdy cover (*e.g.*, submerged branches) by wading through it, then net them as they flee through open water.

When found, tadpoles are best captured and handled using the methods described in Section *4b* (Techniques: Capture and Handling). Remember that frog larvae are delicate creatures, and should be handled (and removed from water) as little as possible!

Night time surveys: Although generally less active after dark, the larvae of most species covered here can, under certain conditions, be found at night using a flashlight. Thus spotted, they often remain motionless and can be closely observed or captured, if you approach slowly and quietly, without any sudden movements. However, it is generally impractical to closely search large areas of the water at night. Therefore, success with this method generally requires locating tadpoles (or least your search area) earlier in the day.

Field gear: A fine-mesh net and container are useful equipment for tadpole surveys.

2d. Frog Surveys

By far, most visual surveys for inventory purposes will be directed at adult, or already transformed, frogs and toads. The primary reasons for this are that the adult life stages generally:

- Occur over the largest area and widest range of habitat
- Are present for the longest amount of time each year
- Are easiest to find and identify

As a result, most visual inventory surveys are aimed at adult forms, and opportunistically record of other life stages as they are encountered.

Location

The overall location will usually be determined by the interest of the entity funding the work. Within this, the survey area can be narrowed to the habitat most likely to support the target species, based on factors like:

- Presence of historic records or previous observations
- Distribution of suitable habitat (This, of course, will vary by species, so it is necessary to know the habitat requirements of a given species before selecting areas for fieldwork.)
- History of site management or disturbance. (For example, a site might look good *now*, but have a history of alteration which has previously eliminated the target species and thus makes current surveys a waste of time.)

Timing

As with eggs and larvae, this is the most important aspect of surveys for adult frogs, and will, of course, vary by species and area.

Time of year

Seasonal timing is the most important. Many frogs (*e.g.*, spotted frogs) are difficult to find for a period of several weeks following breeding. Others (like spadefoot toads) are hard to find at any time except during breeding, and weather influences the behavior and visibility of all frogs.

Overall, the time to find frogs and toads is from several weeks after emergence from hibernation (in spring) until late summer. Within this period, frogs are most visible when they become active during or following breeding, and again following transformation of larvae in mid- to late summer. The cool nights of early fall trigger a decrease in frog activity and a return to overwintering sites, with a corresponding decrease in detectability.

The survey season for most frogs in the project zone is April to September.

Time of day

Time of day makes a big difference in detectability of frogs and toads. In general, most frogs and toads are primarily nocturnal,. This is especially true for the largest adults – which, in some species, are extremely difficult, if not impossible, to find during the day.

However, night surveys are outside of normal working hours for most people, and so most surveys will thus take place during peak daylight hours (0900 – 1700), and may begin even later, because of travel time to a survey location. For this reason, combined with a desire to make statistical comparisons, the focus of most amphibian surveys of this type has been standardization of effort, rather than maximum detectability of target animals. In other words, the primary goal has been to keep surveys as identical as possible, in order to minimize the variation in surveyor ability. However, a little knowledge of frog behavior will allow surveyors to increase their efficacy under standardized, daytime conditions. (For example, even though adult frogs are most active at night, they are still present during the day and can often be found if the proper methods are used. In addition, juvenile frogs of most species are usually active during the day, and fairly easy to find, if one knows where to look.) The following section provides information on how to be a more effective surveyor..

Survey conditions

The first consideration with surveys is to conduct them under as similar weather conditions as possible. Standardization aside, this is because frogs behave differently under different weather conditions. Understanding *why* frogs and toads behave as they do is essential to successfully finding them. This brings us to our next point – the difference between frog activity and frog visibility.

Activity *vs.* visibility

It is important to note the difference between frog *activity* and frog *visibility* (or detectability). The former term refers to frog behavior, while the latter describes how easy they are to see. Put another way, the conditions under which frogs are most *active* are not necessarily those under which they are easiest to *find*. For example, many aquatic or semi-aquatic frog species (bullfrogs, spotted, leopard, and Cascades frogs, *etc*.) are most active during warm rains, but at this time, they often move far from water, dispersing widely through low vegetation, and can be difficult to find (especially with any consistency). In contrast, during periods of dry, sunny weather, they move far less, stay near water, and are much easier to find.

At the temperatures over which they are most active, the following generalizations apply to frog activity:

Conditions		**Sky**		**Air**	
Dry	Wet	Clear	Overcast	Still	Wind
↓ Activity	↑Activity	↓ Activity*	↑ Activity	↑ Activity	↓ Activity

*Aquatic frogs are often more *visible* (though not necessarily more *active*) under sunny conditions, as they like to bask at edges and surfaces of water.

Activity and Environmental Conditions

Temperature

Activity of frogs and toads varies by a species' preferred habitat type (*e.g.*, aquatic or terrestrial). In general, frogs are not active during extreme temperatures. Excessively hot or cold temperatures cause them to seek shelter where they can not easily be found. The operating temperature range for most of the species discussed in this survey is roughly 40ºF - 90ºF, but they are most active at ambient temperatures of about 65-85ºF (peak at ~70-85ºF). This is when they will be most easily seen.

Humidity

As might be expected, frogs are generally more active during periods of wet weather than dry weather. Rain stimulates activity and moist conditions allow frogs to move about without risking dehydration. During wet weather, terrestrial frogs may emerge from under ground and beneath cover objects, and move about readily (at the soil surface). Aquatic frogs may leave the water and move some distance over land. The tendency to move is typically greater in juvenile frogs than in adults, and juvenile frogs also usually move farther than do adults.

Wind

Wind speed/intensity is inversely proportional to frog activity. Put another way, *frogs do not like wind*. In general, frog activity is greatest during still (calm) weather. They may remain active during very light breezy conditions, particularly during rain, but as wind speed increases, frogs rapidly seek cover and become inactive. They are very difficult to find during windy weather, and windy conditions are thus a good reason to end a survey.

Visibility

In general, during daytime surveys:

1) Aquatic or semi-aquatic frog species are easiest to find during dry, sunny weather, and
2) Terrestrial frog (toad) species are easiest to find during wet or overcast conditions.

In summary, frogs are most *active* during periods of wet weather and low wind. At moderate temperatures, most terrestrial frogs are more *visible* under the same conditions, whereas most aquatic frogs are more *visible* under dry, still, and sunny conditions, which concentrate them in and around water.

The implications of this to surveys are: For the species discussed here, optimal survey conditions are during still, warm (70 - 85ºF air temperature), sunny (or at least partly sunny) days, for aquatic species and aquatic forms of terrestrial species (larvae). Adults of terrestrial species will be most easily detected during daylight hours by looking during periods of moist, still, overcast weather.

Time of day. As mentioned previously, juvenile frogs of many species are diurnal, and if nights are cool, reach their peak of activity around mid-day. In the very early morning, they are often less active, thus harder to find, and by late afternoon on

hot days, they may again seek some cover, reducing the numbers visible to a surveyor. As evening approaches, they often emerge from cover and become active again for a short period before and following dusk.

Adult frogs are often visible in very early morning, then, in many habitats, have a distinct period of decreased visibility until mid-day, by which point many will emerge to bask or feed at the water's edge or surface. If weather conditions are favorable, they are most visible from this time through late afternoon.

These are general principles. Remember that frog behavior is ultimately dependent on temperature and recent weather conditions. If nights are cool (*e.g.*, during spring and fall, or at high elevations), nocturnal activity is decreased, and frogs are often most active from late morning through mid-afternoon. In contrast, during hot weather, adult frogs may be almost completely nocturnal, and very difficult to find during the day.

When to survey: Given this information, the best times to perform surveys for the species covered here are: Between late morning and late afternoon, under conditions of warm (70 - 85ºF), still, partly sunny/sunny weather, during the period of time between emergence and late summer (April – August) over most of the area covered here.

Methods

Most survey protocols say to "move through habitat, searching for animals", and provide little supporting information. Your success rate will be greatly increased if you know *how* to move and *where* to look.

How to move:

Although amphibian surveying is a lot of fun, you won't find anything if you make it too much of a party. One of the biggest mistakes most new and/or ineffective surveyors make is to underestimate the animals they are looking for. They make the assumption that frogs are inanimate extensions of the landscape, like rocks, which just sit there oblivious to disturbance, and simply need to be approached and picked up. In truth, frogs are quite alert and wary, as befits their status as a prey animal.

The best way to survey is to walk slowly around the bank of a water body and look for frogs, lifting cover objects and disturbing weeds.

Frogs are sensitive to many cues, including light intensity, sound, soil vibration, *etc*., and are usually aware of your presence long before you see them, even though they may not show it. Many will just hide as you approach. Loud or clumsy surveyors rarely see many frogs. Walk *quietly*. This is often hard in waders and marshy areas, but try. If you have to go more slowly, do it. It is better to search a small area carefully than to search a large one poorly. Avoid splashing or stomping. Resist the temptation to talk loudly or chatter constantly. This both a distraction and a way to scare frogs. You will be amazed at how many animals you see when you move slowly and are quiet.

Where to look:

Start with the edge of a body of water. Most surveys define a standard search area ranging from some distance up the bank to some distance out into the water. Forget this. The actual area where searches will be most productive will vary dramatically by location, so it is much more useful to explain *what* you are searching *for*. For aquatic frogs, you want to search the shallows and shoreline of a water body. Most frogs and tadpoles will be in this area. For small water bodies (ponds, ditches, marshy areas, *etc*.), search everything. For large water bodies, start with the north (south-facing) shore, protected bays, and areas with wide, shallow margins.

How far out? Most frogs will be found in shallow water (*e.g.*, less than three feet deep), so if you can't easily wade it or see into it, don't worry about it. The exception to this are surface weed mats (see below), which may grow in deep water and which often harbor frogs.

How far up the bank? About as far as the soil is moist (at the surface). Most frogs don't like to sit on dry soil. So this distance will be greater in early morning (from dew) or after rain, but is often no more than a few feet from the edge of the water. Frogs will go farther from water in places where there is thick vegetative cover to hide them and keep them moist.

Best places to look: Target areas that are bordered by woods or thick brush, tall grass, or slowly flowing water. As you search a site, give special attention to cover – objects that frogs can hide under (to stay moist and protected from predators), such as rocks, logs, or bark near the water's edge, or in –such as patches of grass, weeds, or brush that are along the water's edge or are partly submerged. Turn over rocks and logs and walk through weeds or brush (or disturb them with a net) to expose frogs hiding there. Remember that all cover is not equal. The best cover objects are close to, but not tightly in contact with, moist soil – leaving enough space for a frog or toad to squeeze under.

Start your search along the edge of a water body. Good places to check are where overhanging grass or bushes provide cover (*above, left*). Thick clumps of grass and rushes along the bank (*above, right*) are also likely places for a frog to hide.

Places that are poor and usually have few or no frogs include: swift water (look along slow margins instead), deep water, water with no plants or other cover, bare shoreline with no cover, sandy beaches, steep banks, sharp drop-offs bordering deep water, and shorelines near developed areas (resorts, campgrounds, *etc*.). Remember, when looking for frogs, that you have to consider habitat quality from a frog's perspective – not your own.

Once, while surveying a popular mountain lake, I checked a mile of shoreline for western toads. The lake was clear and rocky bottomed, with a wide pebbly beach framed by tall pine trees. Waves gently lapped the shore. Idyllic by human standards, but almost no toads were found – certainly not enough to explain the abundance of this species in the nearby woods. Perplexed, I visited the only other water in the vicinity – the wastewater settling ponds of a local resort. Here, I found toads in abundance – adults, larvae, and several age classes of juveniles – thousands of animals. Though disgusting and smelly from my perspective, the ponds provided still water with abundant algae growth, supported lush stands of vegetation, and had high insect production – everything needed to support a large toad population. The visit gave me an answer to my puzzle, as well a reminder that it is an animal's preference that determines its location, not mine. To put it another way, one creature's trash is another's treasure!

Shallowly flooded beds of rushes (*above, left*) are excellent places to look for leopard and spotted frogs, as well as tadpoles. The edges of woods or forested wetlands (*above, right*) are good places to look for frogs of all kinds, especially terrestrial forms.

Weed Mats

Many species of aquatic plants will form mats of floating leaves that cover the surface of still or slowly-flowing water. For frogs, these mats provide cover from predators and places to rest. They also attract insects and trap and warm a layer of water. Because of this, they are very attractive to frogs of many species. When weed mats are present, they are worth checking for frogs. However, be careful! They may grow in very deep water (over 10 feet)! If the mat covers a large area, or the water is too deep to wade, use a pair of binoculars to scan it from the bank or a boat. Be patient – frogs usually hide in such weeds with only their eyes showing. You may have to wait until they move before you can spot them! Sitting and watching quietly for a few minutes usually provides the best results.

Over the project zone, some common mat-forming species preferred by frogs are:

Water lilies (*Nuphar polysepalum, Nymphaea odorata*)
Duckweed (*Lemna* spp., sometimes *Wolffia* spp.)
Pondweed (*Potamogeton* spp. – *P. epihydrus* and *P. natans* are favorites)
Smartweed (*Polygonum* spp. – mostly *P. amphibium*)
Milfoil (*Myriophyllum hippuroides*, *M. spicatum*)*
Coontail (*Ceratophyllum demersum*)*
Waterweeds (*Elodea canadensis*, *E. densa*)*

*These species are submergent, but thick stands will make mats at the water's surface.

Weed mats

Floating-leaved pondweed (*Potamogeton natans*) forms a thick surface mat in eight feet of water. These mats provide excellent habitat for many species of frogs.

Thick beds of lily pads provide good habitat for many species of frogs.

Terrestrial Frogs. The methods described previously work best for aquatic and semi-aquatic species of frogs. Terrestrial species, such as toads, may occasionally be found during these surveys (especially recently transformed juveniles), but they will not consistently be found using these methods.

The best way to find terrestrial frogs during daylight hours is to turn lots of cover. Target cover that is located on moist soil – in the vicinity of ponds, creeks, or seeps. Cover in or at the margins of woods, and thus partly shaded, is also good.

The best types of cover to check include: rocks, bark, rotting logs (even inside these, if they are really rotten), leaf litter or debris, trash (especially wood and cardboard), and the mouths of rodent burrows. Be prepared to search thoroughly – toads can be very difficult to find during daylight hours, especially under dry conditions. During or immediately after a rain, your chances of success will increase considerably. At these times, do not bother with cover objects, but instead walk slowly through good habitat, looking for movement. Walking or driving paths or roads through a desired survey area is also a good technique.

If little cover is present in an area, you can increase your success rate by placing boards (2' x 2' plywood squares work well) around the spots that you want to survey prior to going out. (The longer before your survey that you place them, the better – but even a week before is OK if the weather is wet. Be sure to place the boards so that frogs and toads can squeeze underneath them.)

Left: Rotten logs around wetlands are prime cover for frogs, including terrestrial species, breeding adults, and newly transformed young.

Right: Check under cover objects, like rocks and logs.

Night surveys. The above methods apply to daytime surveys. At night, concentrate surveys for aquatic or semi-aquatic species along the edges of water (aquatic forms will often leave the water at this time) and in shallow areas. For terrestrial species, check the edges of water (many toads will visit water at night), the vicinity of lights (toads often hang out near lights to catch insects), and roads though suitable habitat (this is most effective during rain).

Other methods. A number of other methods are used to catch frogs and toads. These include funnel-trapping, pit-trapping, and road hunting. With a few exceptions, the first two methods require too much time and effort to be really useful for inventory survey purposes, and so will not be discussed further. The third, however, can be extremely useful for inventories if conducted at the right time, since it allows a surveyor to cover a large amount of area quickly and with very little effort.

Road hunting is a simple technique: slowly drive roads through areas you want to search. The best roads are those that pass through good habitat (see below), and have little or no night-time traffic. Avoid roads that are busy and have no shoulders or pullouts.When driving, go slowly enough that you can both *see* small objects on the road and *be able to stop for them*. Depending on the weather conditions, 30 mph is a good general speed. Go slower if the visibility is poor or if many animals are out. It is often useful to have a passenger look for frogs while you drive. Frogs are best spotted with the headlights focused on the road (*i.e.*, no "high beams"). Spotlights will really help you see small animals, but they are prohibited in some areas, so check the rules first. If you road hunt long enough, you will probably get pulled over and questioned by police. Even though you are not doing anything illegal, be polite and courteous, and remember that "frog hunting" is a pretty odd story for an officer to swallow, so be prepared to give an explanation.

Within the survey area described here, road hunting works best for terrestrial species, during three specific times of year: 1) early spring, 2) summer rainstorms, and 3) early fall.

1. Spring. On rainy nights of late winter or early spring when nighttime temperatures first begin to increase (generally, wait for temps of 45ºF or higher: ≥50ºF is ideal), drive roads near water or suspected breeding sites. This is when many frogs make their spring migration from the area in which they spend the winter to where they are going to breed. The migration at this time will be brief but intense, and if proper timing is used, many frogs can often be found in a short time. (The best timing is after a day or more of warmer temperatures and rain.) Most frogs found at this time will be reproductive adults.

2. Midsummer rainstorms. Often the best time of year to find adult toads. Especially during spring and early summer, a rainstorm will cause toads to surface and move about. Rain during the afternoon and evening is best, and will stimulate the most activity. Some species (Woodhouse's and spadefoot toads, for example) breed following heavy spring rains. Movement is not often of long duration, so timing has to be precise, but an opportunistic road trip during a rain storm can be extremely productive. Be sure to decide where you want to check in advance, so you don't waste time trying to figure it out when conditions are good.


Rainstorms during spring and early summer coax terrestrial frogs to emerge from hiding and breed in temporary pools. Photos of Great Basin spadefoot, *Spea intermontana*.

3. Fall. The first heavy rain of late summer and early fall permits dispersal of juvenile frogs and toads, and in some places, many animals will be visible crossing roads. Like during the other two good times, it rarely lasts long, and is best at night. Once it has begun to rain steadily, and/or night time temperatures begin to cool too much for frogs to be active, the migration will end. The first few rainstorms are always the most productive.

Section 3: Data and Equipment

3a. Survey Data

"Question of Interest"

The single most important factor determining what data are collected during a project is the specific objective of that project, also called the "question of interest". Since projects don't all have the same goal, the data collected for each project will vary. This seems intuitive, but many projects fail because nobody stopped to consider whether or not the data being collected were appropriate to the question of interest.

Field time, under ideal conditions for surveying or detecting target animals, is a finite and precious resource. Therefore, it is best to avoid exhaustive collection of unnecessary data by first considering the desired objectives of a given project and ranking them in terms of priority.

Inventory Surveys

For inventory surveys of new territory, where the primary objective is establishing which species are present and where they occur, the following should be recorded for every survey:

1. **Surveyors present.** Record the full name of each observer.

2. **Date.** Use the Gregorian calendar, and write out the names of months to avoid confusion – for example, 24 February 2012.

3. **Survey interval.** Record both start time and end time. Use 24-hour format to avoid confusion between AM and PM surveys. This variable is useful for interpreting survey results, including catch per unit effort and success or failure at finding animals.

4. **Weather conditions**. Since the primary importance of this variable to a survey of this type is to interpret success or failure at finding animals, these can be as simple or as detailed as you like.

   At minimum, describe weather conditions in a way that will let a reader identify what they were like during the survey. Generalizing over a long (and potentially variable) survey interval is usually more informative than recording start and end conditions.

   The most important weather variables are:

   - **Air temperature**. The temperature of still air. When measuring, keep the thermometer probe sheltered from the wind, and out of the sun.
   - **Sunny vs. cloudy**. This variable may be expressed *qualitatively*, as a description (for example, "partly sunny"). It may also be expressed *quantitatively,* as a numeric value (% cloud cover, cloud type, height, *etc*.). Again, this is a variable that is best averaged over the survey interval.

- **Presence of wind**. This is very important to amphibians. It may be expressed as either a qualitative description (still, light breeze, windy, *etc*.) or quantified (*e.g.*, via the Beaufort scale).
- **Precipitation**. Record the type of precipitation (rain, snow, *etc*.), and its intensity (light, heavy, *etc*.).
- **Recent weather conditions**. Weather conditions of the past day or two are important because they influence the activity, and hence detectability, of target animals. Examples of important weather conditions include: heavy rain, low night-time temperatures, and hot.or dry weather.

Beaufort Scale for wind speed

No.	Knots	Mph	Description	Effects at sea	Effects on land
0	0	0	Calm	Sea like a mirror	Smoke rises vertically
1	1-3	1-3	Light air	Ripples but no foam crests	Smoke drifts in wind
2	4-6	4-7	Light breeze	Small wavelets	Leaves rustle; wind felt on face
3	7-10	8-12	Gentle breeze	Large wavelets; crests not breaking	Small twigs in constant motion; light flags extended
4	11-16	13-18	Moderate wind	Numerous whitecaps; waves 1-4 ft. high	Dust, leaves, and loose paper raised. Small branches move
5	17-21	19-24	Fresh wind	Many whitecaps, some spray; waves 4-8 ft. high	Small trees sway
6	22-27	25-31	Strong wind	Whitecaps everywhere; larger waves 8-13 ft. high	Large branches move; difficult to use umbrellas
7	28-33	32-38	Very strong wind	White foam from waves is blown in streaks; waves 13-20 ft. high	Whole trees in motion
8	34-40	39-46	Gale	Edges of wave crests break into spindrift	Twigs break off trees; difficult to walk
9	41-47	47-54	Severe gale	High waves; sea begins to roll. Spray reduces visibility; 20 ft. waves	Chimney pots and slates removed
10	48-55	55-63	Storm	Very high waves, 20-30 ft.; blowing foam gives sea white appearance	Trees uprooted; structural damage
11	56-63	64-72	Severe storm	Exceptionally high waves, 30-45 ft. high	Widespread damage
12	63	73	Hurricane	Air filled with foam, visibility reduced. White sea; waves over 45 ft. high	Widespread damage; rare

5. **Survey location.** This variable describes where your survey takes place, and allows you to relocate the spot afterward. For the inventory protocol, location data should be recorded in three ways:
    - ***A description*** of your location. Include state, county, and specific location, including unit on a refuge. For example: northwest corner of Willard Unit, Conboy Lake NWR, Klickitat Co., WA. If necessary, reference landmarks to your position.
    - ***Coordinates*** of your location. UTM coordinates are a good choice. They are widely used, are accurate, and are easy to map. Record zone and datum as well.
    - ***A reference photo*** of your survey location. A distinctive landmark or your survey start point (e.g., where coordinates are recorded) make good reference photos.

    Be sure to record location in each form, whenever possible. Exact coordinates are good for mapping and GIS use, while a written description of a location is more useful for field reference and quick identification. Your photograph will help verify your coordinates and written location. Remember, your location data should have enough detail that somebody else could easily find the place you are describing.

6. **Habitat.** Make a general description of the location and type of habitat present. Give special attention to habitat features, especially water features, since they will influence amphibian distribution. Some of the most important are:
    - Location of water (or distance to the closest body of water)
    - Water body type
    - Average water depth (of survey area)
    - Average water temperature (of survey area)

    Rather than attempting to measure a number of habitat variables immediately on arrival at a survey site, an often better (and more accurate) technique is to record the 'average' habitat type present, after the survey is complete. Detailed notes on habitat conditions may also be recorded for specific locations within the survey area where animals are found.

    Vegetation is extremely important in determining amphibian distribution and should be noted for each survey area. Record a general description of percent cover and community type for each survey site.

    Reference photos of typical or 'average' habitat should be taken at each survey site.

    Habitat variables requiring more detailed or long-term investigation, such as hydrology, fish presence, *etc*., may be noted opportunistically, but are often difficult to determine in the field and can be investigated before or after a site visit, if necessary.

7. **Amphibian species observed.** A number of variables are important here. They are as follows: a) species, b) life stage, c) number of individuals, d) location, and e) habitat. Additional data that can be recorded and is often useful includes: f) the time of observation/discovery, g) size of one or more individual animals, h) behavior of animals, *etc*.

   a) Species: Record the species found. The first time you record a species during a survey, use both the common and scientific name for the animal. For example: Oregon spotted frog (*Rana pretiosa*).

   Subsequent observations can be designed with a standard species code. The standard code uses the first two letters of the animal's generic and specific names. Example = Genus species = GESP. For the Oregon spotted frog, this would be Rana pretiosa = RAPR. Avoid self-invented codes: they are not standard and cause a lot of confusion.

   For the first observation of a species in an area (locality record), the first observation of a species during a survey, or if you are not sure what species a particular animal is, collect a voucher (photo or specimen). Photo numbers should be recorded in written notes (*e.g.*, photo #24/300 on digital camera card) corresponding with an individual specimen (*e.g.*, 1240 *Rana pipiens* = photo #25-27 on 4/7/2011). Voucher specimens should be labeled, with the label corresponding to a reference in the notes (e.g, 1251 *Hyla regilla* collected as voucher).

   b) Life stage: Egg, larva (tadpole), metamorph (larva with at least one front limb *and* a tail, or tail stub – this life stage requires careful observation and is optional), or frog/toad (no tail).

   Sizes of frog can be estimated or measured (see below). Be sure to indicate in writing whether a size given is an estimate or a measurement. Estimates of size are fine, but avoid using descriptors that require prior knowledge of a species' life history (*e.g.*,"second-year", "subadult"). This type of information is lacking at a newly inventoried site, and making such unfound assessments often leads to big problems later on. Even though such descriptors may seem reasonable to you at the time, don't do it.

   c) Number of individuals encountered: An entry may be made for each individual, or for a group of individuals.

   The former is often done for adult frogs or toads (or egg masses when singly found), the latter when animals are numerous, as in the case of larvae or (small) froglets. Regardless of how data is organized, be sure to note in writing how many individuals are represented in each entry. Do not combine

individuals of different sizes or life stages into a single entry – this is confusing and results in the loss of valuable information.

d) Location of the animal within the survey area: As before – exact coordinates are more useful for mapping and subsequent analysis, while an accurate written description is much more valuable for future reference and practical use. Record in both formats, if possible.

e) Habitat: Microhabitat at the location of the animals. Basically, what is the habitat where the animals are, and where are they in it? Answering these two questions will tell you a lot of what you need to know with respect to understanding a species' use of an area. It will reveal what aspects of habitat are most important to that species, and it will allow you to find them again. Including notes on vegetation and temperature (air and/or water) at the animals' location will dramatically improve the quality of your data.

f) Time of discovery is partly an artifact of when the survey is conducted, but if recorded reliably, it may yield some valuable insight into animals' behavior, and subsequently increase your success at finding them. It also provides a useful identifier for animals encountered during a survey, and allows for easy and accurate organization of data. Record multiple animals captured at the same time with letters (*e.g.*, 1221a and 1221b).

g) Measuring large samples of animals or making repeating measurements of individuals are techniques that are really more suited to detailed life history studies, but making reference measurements of a few individuals during a survey will rapidly add a great deal of value to your data.

Measuring a small sample (*e.g.*, 3-10) of "average" animals in each size class or life stage encountered will assist in identification, provide insight into life history (growth rate, phenology, *etc*.) and habitat use, and will dramatically improve the success of future surveys. Even just a measurement of one "typical" animal is useful. (Measurement techniques are described in the "Capture and Handling" section).

h) Behavior of the animals you encounter is another variable that will provide you valuable insight into habitat use, help you to interpret your capture/observation data, and ultimately allow you to increase the success rate of your surveys.

For example, are animals on the move? Or are they sitting quietly? Are they gathered in the shallows, or hiding singly in deep water or weeds? (Remember that if you are not a stealthy surveyor, a lot of animal behaviors will resemble "escaping".)

8. **Other variables of interest** ("notes"). Think about it. What other factors, relative to your survey or survey area, might help you interpret or understand your survey results? Are there peculiar habitat features, man-made objects, patterns of disturbance (such as boats, traffic or human use) that may affect what you see? Is there a break in capture/observations because you stopped for lunch, portaged around a dam, or ran out of batteries? Are there amphibian predators (fish, herons, otters, garter snakes, water bugs, small boys, *etc*.) around? Whatever it is, write it down at the time you observe it – because if you don't have it in writing, you don't have it!

3b. Organization and Interpretation of Data

Step 1. Organization (*what do you do with it?*)

Data is useless if it is not readily accessible. Organization of data will, to some extent, depend on how it is collected and what it is to be used for (again, the question of interest). The following are a few suggestions for managing inventory data.

Specimens. If an amphibian study is to be long-term, specimens can be stored on-site, at a refuge headquarters or regional office. There, they are accessible to managers and staff and will be useful in training and research. However, remember that preserved specimens need maintenance. Therefore, if the amphibian program is irregular or the number of specimens accumulated is large, they are best sent to a collection at a natural history museum or university, from which they can be retrieved for examination, if needed. When doing this, it is best to pick a local or regional collection in which to place specimens. Don't send them to an obscure or faraway location from which they might not be accessible. Specimen information should be recorded in a data base before they are sent away, to avoid loss and/or error.

Photographic vouchers can also be sent to a museum collection after backup. Consider placing copies in a centrally accessible network folder, where they can be linked to entries in a database. When choosing formats, .jpg files are good because they can be easily resized.

Written data is, as mentioned above, best entered in an electronic database. In addition to data entry, hard copies of data sheet (or notebook pages) are easily scanned and saved as .pdf or graphics (.jpg, .bmp, etc.) files. Electronic files of this type are also easily linked to database entries. This is a good move since hard copies are easily lost.

One of the simplest and most effective ways to set up a database is to populate it with fields that match your collection form. This way, data entry is easy and data can be quickly checked against original forms, should questions arise. Further manipulations can be performed in other sheets.

Step 2. Analysis and Interpretation. (*What does it mean?*)

There are many different methods of data analysis, a thorough discussion of which is beyond the scope of this manual. As with data collection, methods of data analysis ultimately depend on the original question of interest. For inventory and monitoring surveys of this type, the most important questions are those of: 1) detection, 2) distribution, and 3) identifying trends. Put another way: is the species present, where is it, and how is it doing?

Detection. The first and most important goal of an inventory is to determine whether or not a species occurs in a given area – on a refuge, for example. To answer this, surveys are performed using appropriate methods. If the species is detected within the survey area, it is now known to occur there. If, however, it is not detected, it is not necessarily absent.

Failure to detect a target species during a survey does not automatically mean that the species does not occur there. It means you didn't find it. Some of the most likely reasons a target species is not detected in a survey area are as follows:

1. The survey was conducted at the wrong time (timing).
2. The survey was conducted the wrong way (method).
3. The target species is not present (actual absence).

1. **Timing**. The timing of a survey is the single biggest influence on results. It will almost solely determine what is or is not found. For example, many frogs and toads breed over a very short period of time, and their larvae develop rapidly. Surveying a breeding site after larvae have transformed and left will give you no indication that the site was used for breeding. Surveying too early (before breeding) may also result in a failure to identify breeding habitat. Surveying when frogs are not active (wrong time of year, wrong weather or temperature conditions, wrong time of day) can also give negative results.

2. **Survey method**. The purpose of this report is to provide instructions on how to properly survey in order to have the best chance of success. However, no one protocol, no matter how detailed, will be able to cover every possible combination of survey conditions and variation in habitat. Sometimes, seemingly proper surveys that are unsuccessful in an area should be re-evaluated in terms of the specific conditions present at that site. For example: What is the cover like? What are the weather and/or temperature conditions like? Altering a 'standard' survey to fit local conditions often results in success.

   Finally, too, there is the matter of the surveyor. In general, the more experience a person has with the survey area and/or with finding frogs, the more likely they are to detect them. However, there is considerable variation among surveyors. Some people will be consistently good at finding frogs; others will be consistently not good at finding them. (The causes of people's difference in ability are diverse and beyond the scope of this report.) Sometimes, a change in surveyor will result in a change in detection.

3. **Target species really isn't there**. The last major cause of detection failure is that the target species truly does not exist within the survey area. If repeated, properly conducted surveys fail to turn the species up, it may simply just not be there. There is a growing body of statistical analyses that address detectability and the probability of missing a target species when it is, in fact, present at a very low level, but these are beyond the scope of this report.

   When considering detectability, it is important to remember what is, and what isn't, an appropriate application of a given technique. Remember to consider the question of interest. The general protocol given here is designed to teach basic

survey techniques. It allows anyone to conduct an inventory of frog species present in a given area. The species-specific protocols allow the user to conduct surveys for target species the same way. Both provide an accurate means of gathering information in an area where none exist. However, any method is only as good as the person applying it. If the surveyor is inexperienced, the results will reflect that, no matter how detailed the protocol. It is inappropriate to expect someone with no prior experience to find a rare species on their first try.

Therefore, if it is important that a particular species be detected quickly, it is best to use a surveyor who has previous experience with that species. The value of experience, prior knowledge, and a well-developed search image cannot be overstated.

Distribution. This aspect of data analysis is fairly straight-forward: Within a target area, where does a species occur, and where does it not? Distribution can be verified through actual surveys, or predicted via a model that bases occurrence on some kind of attribute, such as habitat type. The former method is best for small or easily survey areas, and the latter is useful over large areas that cannot easily be surveyed. Remember, though, that predictive models are only as good as the information that goes into them. If a model is made without an accurate understanding of a species' biology, habitat requirements, *etc*., it will be worthless as a predictor.

Keep in mind that some species have different habitat requirements at different times of the year (*e.g.*, breeding vs. non-breeding habitat), and their distribution will therefore reflect that. Many new tools exist for the visual display and examination of distribution information. ArcView (GIS) is one of these.

Identifying Trends. The third important question regarding management of a species is: Now that you know *if* a species is present, and *where* that species is (*i.e*., what is important habitat), you now want to know: *How is it doing?* This concept is also known as "monitoring".

The ability to identify trends (either in species density or distribution) is directly related to the detail and duration of your data. In other words, the larger your sample size (with respect to the number of surveys performed), and the longer the period over which you collect data, the more accurately your data will tell you what is going on.

Put another way: The more (identical) surveys you conduct, the less uncertainty (or error) will be associated with each survey (= the more accurate they will be), and the longer you perform surveys, the less of an effect short-term variation will have, and the more accurate your overall "picture" will be. This is important – many factors can alter the number of animals observed during a survey, especially to an inexperienced observer. And many amphibian populations fluctuate dramatically from year-to-year, as the result of factors like weather and predation. Short-term variation in population size is normal, and not necessarily an indicator of decline, except in catastrophic situations. Only a long-term period of observation will allow you to separate short-term variation from an actual trend.

Period of observation

What is a long-term period of observation? The short answer is: The longer, the better. Amphibian populations often fluctuate dramatically, and observers with little data usually interpret a short-term fluctuation as a decline. To be accurate, the period of observation will depend on the lifespan of the organisms involved. Specifically, identifying a long-term trend requires watching a population across multiple generations – as many as possible. This is research that requires a considerable amount of time, even in the case of relatively short-lived species, such as spotted frogs. This also raises a problem for biologists, who are usually required to assess a long-term biological phenomenon over a short-term schedule. There is no easy solution to this problem. Whatever you do, try to keep the "bigger picture" in mind when interpreting survey data.

Considering scale

One last point in this regard is that scale should also be considered when interpreting decline. Scale, on both a temporal and spatial level, puts a fluctuation or decline into context. The geographic ranges of most species naturally fluctuate over long periods of time as the result of changes in that species' environment. Such fluctuation does not necessarily mean that the species is irreversibly declining or going extinct. Populations at the edges of a species' range are generally more prone to fluctuation than those at the core of the range. This is an important point to remember if you are tasked with maintaining such a population. Although the only scale a manager may be allowed to consider is that of his or her refuge, the concept of scale may help put management decisions into context.

Using historic data

Finally, it is worth mentioning that trends can sometimes be inferred if historical data are available, a method that has gained much popularity in recent years. Basically, zoological inventory has been conducted long enough in certain areas that historical occurrence data can be compared with the results of current site surveys (often termed "revisits") to see if the species in question still occurs there.

Regarding this practice, a couple points merit mention. First: Although, on rare occasions, detailed field notes will suffice as the historical observation, most historical records should only be considered valid if they are represented by a properly documented specimen. Second, most historical records are fairly limited in scope, and permit little quantitative comparison with current observations, except to say whether species formerly present in an area are now absent. Despite this, if used properly, examination of historic records for an area in question is a valuable tool for determining and interpreting decline and guiding management.

3c. Survey Equipment

1. **Data Sheet / Notebook**. The data sheet is the most important piece of equipment you will take on a survey. It provides a fast, easy, and accurate means of recording information for future use. There are many existing data sheets – almost as many as there are studies. The best sheet for your survey will most likely be of your own design – set up in a way that makes it easiest for:
   1) the primary observer or surveyor to record data in the field, and then
   2) read that data for entry into a spreadsheet or computer database.

   To avoid creating a cluttered, intimidating data sheet that is hard to use and fosters confusion, don't try to put too many variables on a single page. Before going out to sample, design your data sheet to include the factors which you consider most important to record. Consider which variables can be most easily recorded in the field during an initial survey visit, and which may be collected during follow-up visits, or from other sources. For example: habitat type, water body type, and dominant vegetative cover are easy for most observers to record during an initial visit, while hydroperiod and presence/absence of fish are more difficult to determine during this type of visit.

   Again, avoid the temptation to include fields for every variable (or type of data) you can think of. A streamlined, simple data sheet will result in more accurate information. Blank lines or fields are very useful when recording variable data – avoid the temptation to try and quantify every parameter, especially before you have used the data sheet in the field. Changes to the data sheet fields are best made following actual use during surveys, at which point the observers will have a chance to determine what is important, and what is not (or, what works and what doesn't).

   Sample datasheets are included in Appendix 8.

   Material

   The best material from which to make a datasheet is "Rite-in-the-Rain" waterproof paper. The "all-weather" copier/laser printer is easy to print on (laser printer only – it will not print from an ink-jet or 'desk-jet' printer) or photocopy. The author prefers the green all-weather paper (item #9511, J.L Darling Corp., Tacoma, WA USA – (253)-922-5000, www.riteintherain.com), but the paper is also available in white (#8511). Both colors are 20# paper.

   This paper can be written on with: #2 pencil, waterproof pencil (General's, #881), and Rite-in-the-Rain's pressurized waterproof ballpoint pen (recommended – expensive but durable, long-lasting, and well worth the price) which is available in black (standard), blue and red. It can also be written on by standard tip, waterproof Sharpie marker (Sanford Co.). Other pens, including ballpoint, gel pens, and some fine-point Sharpie markers, will not write on this paper.

   Rite-in-the-Rain paper can also be used to make specimen tags. For labeling specimen tags, use a #2 pencil and press heavily. The rite-in-rain black ballpoint

pen will also work, and is fairly stable, although it will run slightly in solvent (ethanol, isopropanol), enough to color a preserving solution.

Notebooks

A notebook may be used instead of a data sheet. Some advantages of a notebook are that it is smaller, more portable, and more durable. Disadvantages are that it takes longer to record information (no pre-printed fields), and depending on the quality of the observer's handwriting, it may also be more difficult to retrieve and enter data. Really, it does not matter which is used, as long as the necessary data is recorded, but the author strongly recommends that anyone seriously interested in amphibian science or surveying carry a notebook with them at all times, as the best observations are usually opportunistic. The author carries Rite-in-the-Rain's "all weather field book" (#980) with him at all times (covered in a green nylon zipper case (#C980) that holds pencils), and finds it invaluable.

Other notebooks are even smaller and more portable, and Rite-in-the-Rain also makes a number of nice plastic-bound, pocket-sized notebooks which are very convenient and durable. The best and most durable are the "Dura-Rite" bound notebooks made for underwater use. The author strongly recommends them for harsh weather conditions.

2. **Writing implements** (pencil and pens). The best writing implements for field use are a #2 pencil, waterproof pencil (General's, #881), and Rite-in-the-Rain's pressurized waterproof ballpoint pen.

3. **Dip net**. The dip net is an invaluable tool for sampling amphibians. One useful type is the "bait dealer" net. A good size for inventory surveys has a 42" handle and 12" deep net. (Standard mesh size for these type of nets is 1/8". However, 1/16" mesh is best for early-season sampling, as it will allow you to catch small larvae that pass through the regular mesh.) This net will work well for most native frogs and their larvae – for large leopard frogs and bullfrogs in deep water, use fine-mesh landing or electrofishing nets, with at least a 16" deep bag, as these species will jump out of a 12" net.

   For sampling small larvae (and sometimes tiny juveniles), use a fine-mesh aquarium dip net – it has the smallest, softest mesh of any net you can buy, and it is easiest on these forms' delicate skin and mucous covering. Aquarium dip nets can be bought at most pet and department stores. These nets are small and easy to carry in a backpack. Using a pencil case for carrying them (or putting a Ziploc freezer bag over the net) will reduce net tearing and greatly prolong their life.

4. **Waders**. Many surveys will require the use of waders. For cold water/weather, 5mm neoprene stockingfoot waders are good. For all other weather, or extensive walking, breathable stocking foot waders are recommended. Stocking foot design is better than boot foot for surveys: they allow change of footwear between sites and substrate conditions, can be used by more than one person (in a pinch), and can be much more easily cleaned, dried and repaired.

Compared to thick neoprene, breathable waders are easily punctured, but can be protected by wearing a pair of rain pants over them. When they are used in thick brush, ice, or other rough conditions, this will dramatically prolong their life. In cold conditions, wear warm thick polypropylene or wool socks and thermals beneath breathable waders. For thermals, choose type (weight) accordingly – don't use heavy weight for anything shallow, warm or where you are constantly moving – and don't use lightweight for long periods of standing in ice water.

5. **Boots**.
    a. For shallow wading, rubber or PVC knee boots are best (neoprene boots are OK, but they wear out quickly and are hard to sterilize).
    b. For wearing over waders, the same type of PVC boots are best for rough or brushy conditions, since they protect wader feet. Remember to buy them a size larger than normal, to account for the extra layer of wader feet. If boots get too heavy when filled with water, drill small holes in the sides to allow rapid drainage. For conditions which are not too rough or brushy, shorter (*e.g.*, hiking boot style) wading boots work well, and are usually more comfortable when worn for long periods of time.

6. **GPS**. A GPS unit is valuable for determining location, recording position, *etc*. Small handheld units are economical and easy to carry.

    Warning! Most GPS units are not as tough as the manufacturers claim (or, for that matter, are anything near waterproof). Screens are especially smashable. Plan accordingly.

7. **Digital thermometer**. Get one that is waterproof, with a sealed case and stainless steel probe. Actually, get several. They are easily lost/stolen. Do not trust them implicitly, but check them frequently against a good liquid-filled thermometer. They do malfunction, and failure to check frequently will cost you valuable data. These are essential.

8. **Ziploc bags**. You will use these for everything. Get three kinds: light plastic sandwich bags, quart freezer bags, gallon freezer bags. Essential.

9. **Spring scales**. Optional but very, very useful. Get the following sizes for amphibian surveys: 30g, 100g, 600g, and 1,000g. Don't waste your money on the plastic tube scales, they will break. Good scales for field use have a machined aluminum tube housing, an alligator clip and a wire top handle. They have a dial calibration that allows you to tare weighing bags and zero scales. Check that scales are zeroed each time you use them, before you weigh something. Get the sliding plastic protector tubes for them, and drill some small holes in the tube ends if moisture is a problem. For frog inventory surveys, the most useful models are as follows:

Pesola Scales	Range	Increments	Product Number
30 g	0-30 g	0.5 g	20030
100 g	0-100 g	1 g	20100
600 g	0-600 g	5 g	40600
1,000 g	0-1,000 g	10 g	41000

10. **Digital camera**. Avoid large cameras that are heavy and delicate. For survey needs, a good small SLR camera with a zoom lens and macro capacity will work just fine. Small and portable is important; shock- and waterproof even more so. Buy a high-capacity memory card and at least one extra battery.

    Find the "normal" and macro settings and learn how to switch between them and how to take a macro shot. See "Photography" section. This is an absolutely essential piece of equipment. Learn to use your camera. Pixels are cheap, but one good photo is worth a hundred grainy blobs.

11. **Backpack**. As a means of carrying gear, a small day pack with padded straps works well. Choose a pack that is large enough to carry necessary equipment, but not so large or cumbersome that it becomes uncomfortable or hinders movement when wading or catching frogs. Avoid full-size backpacks and heavily loaded bags – they will slow you down and get you into trouble. Backpacks also help you carry your #1 most important item – drinking water.

12. **Plastic ruler**. Absolutely essential. For measuring amphibians and everything else. Six-inch length is the most convenient to carry. The flexible, smooth plastic rulers are best for most applications. Get a bunch and put them in your backpack, truck, field notebook (even taped to the edge of the clipboard or book cover), *etc*.

13. **Disinfection chemicals**. 90% ethanol, isopropanol, or 5-10% bleach (NaClO) solution in a spray bottle. For cleaning equipment and preventing the spread of disease between sites. Thoroughly spray waders and boots at the end of a survey, and let stand for 10 minutes. If you use bleach, rinse them off thoroughly afterward, or your gear will be quickly destroyed. Jars can be cleaned with alcohol (it will evaporate), or with a solution of mild dishwashing soap (rinse thoroughly afterward to wash out any soap residue). See Section *4g*, "Disinfection", for more information on cleaning gear.

14. **Drinking water**. Take enough to last the entire survey, plus as much more as you can comfortably carry.

15. **Additional equipment**. The following are not absolutely essential, but are very useful, and the author carries them:
    - Sharpie marker. For writing on bags, flagging, etc.
    - Flagging tape.
    - Measuring tape. Fiberglass, metric/English graduated (sewing section of department store).

- Small flashlight or good LED headlamp.
- Specimen jars. Plastic, screw-top, with tight-fitting lids are best. A variety of sizes. These are very useful for examining small specimens. You will find yourself using these a lot. Sterilize after use.
- Good knife. Pocket knife or easily accessible utility knife.
- Compass. Good, liquid-filled compass, with a flip-top and sight line if desired. Get a good one and pack it carefully. When you need it, you need it bad.
- Map of work area.
- Field guide. Use a guide that is specific to the area you are surveying. See Section *4a*, "Identification", for a list of guides.
- Fire starters. (Match/lighter/tinder in waterproof case.)
- Space blanket.
- First-aid kit with Ace bandage. Sprains are a common field injury, and besides, Ace bandages are useful for a lot of other things. Your first aid kit should also include a pain reliever, like aspirin or ibuprofen, and allergy medicine, like Benadryl.
- Cloth bags and/or garbage bags. Bags don't take up much space, and you never know what you will find. You can carry live animals in a cloth bag, and almost anything else in a garbage bag.
- Water. DRINKING WATER.
- Photography containers (Rubbermaid tub, aquarium/terrarium).
- Collecting supplies (chemicals/trays/cooler with ice). These and photography containers are a pain to carry around; just leave them in your truck in case you need them.
- Rope or twine.
- Bug spray. Keep it away from frogs: most insect repellents are lethal to amphibians. Like with the compass – when you need this, you will be very glad you have it.
- Duct tape. Who doesn't need duct tape?

3d. Sources of Equipment

Company	Address	Phone	Website	Products carried
VWR LabShop	800 East Fabyan Parkway, Batavia, IL 60510	866-360-7522	http://www.vwrlabshop.com/	Chemicals
Carolina Biological Supply Company	2700 York Road, Burlington, NC 27215-3398	800-334-5551	http://www.carolina.com/	Specimen jars, chemicals, plastic rulers, *etc*.
Forestry Suppliers	205 West Rankin Street (PO Box 8397), Jackson, MS 39284-8397	800-752-8460	http://www.forestry-suppliers.com/	Digital themometers, spring scales, *etc*.
Pesola AG	Rebmattli 19, CH-6340 Baar, Switzerland	+41 (0)41 769 60 40	http://www.pesola.com/e/	Spring scales
Cabela's	Multiple locations in ID, OR, WA	800-237-4444	http://www.cabelas.com/	Waders, boots, thermals, backpacks, GPS units, *etc*.
Cumings Net Company	2305 Branch Road (PO Box 90118), Flint, MI 48506	810-736-0130	http://www.cumingsnets.com/	Dip nets
Nylon Net Company	PO Box 592, Memphis, TN 38101-0592	800-238-7529	http://www.nylonnet.com/	Nets, twine, rope
Memphis Net and Twine	2481 Matthews Avenue Memphis, TN 38108-2403	888-674-7638	http://www.memphisnet.net/	Nets, twine, rope
Argent Laboratories	8702 152nd Ave.N.E., Redmond, WA 98052	800-426-6258	http://www.argent-labs.com/	MS-222 (tricaine methanesulfonate)
Western Chemical, Inc.	1269 Lattimore Road, Ferndale, WA 98248	800-283-5292	http://www.wchemical.com/	MS-222 (tricaine methanesulfonate)
SKS Bottle and Packaging	2600 7th Avenue, Building 60 West, Watervliet, NY 12189	518-880-6980 ext.1	http://www.sks-bottle.com/	Specimen jars and containers
J.L. Darling Corporation	2614 Pacific Hwy. E., Tacoma, WA 98424	253-922-5300	http://www.riteintherain.com/	Rite-in-the-Rain paper, notebooks, and waterproof pens
Hamilton Bell Company	30 Craig Road, Montvale, NJ 07645	800-526-0864	http://www.hamiltonbell.com/	Plastic rulers, dissecting equipment
Amazon.com	Multiple distributors		http://www.amazon.com/	Field guides, reference books, thermometers, containers, *etc*.

Section 4: Techniques

4a. Identification

Identifying Frog Eggs

Identifying eggs is not always easy. The flocculent, silt-covered blob you encounter in the field may not resemble its picture or description in your guide book. The best way to identify eggs is to:

1. **First**, narrow down the possibilities. Make a list of the species known to occur in your area. This is where a good field guide comes in handy. For convenience, Appendix 2 contains a list of species which occur in the project zone.
2. **Second**, reduce the list of possible suspects to those who breed at the time of your survey, and in the types of habitats you are finding eggs in.

The resulting "line-up" of potential species should be short enough that you can figure out which frog you have eggs from.

As they age, frog egg masses often become distorted (*left*) or covered with silt (*right*) and can be hard to identify.
Photos of northern red-legged frog (*Rana aurora*) egg masses.

However, a number of conditions (including turbidity, water and frog movement, *etc*.) can greatly alter the appearance of an egg mass, and sometimes you still can't tell what kind of eggs they are, even after following the steps above. A few more tips, then, in case you find yourself in this situation:

3. **"Go with the crowd" or "majority rules".** Although different species of frogs will lay their eggs in the same pond, most of the time, a series of eggs from the same species will look pretty similar. Therefore, consider the identity and appearance of the other egg masses you are finding (*i.e*., what else is there?). For example, if you have 100 spotted frog egg masses in a pond, and you haven't found any other species during that survey, and you find an egg mass that doesn't quite look like the others, but it's in the same place as the others, and it's about

the same size as the others – well, then it probably *is* a spotted frog egg mass. It might not be – it *might* be something else – but it probably isn't.

4. **Photograph**. Although it may be difficult to get a photograph of an egg mass good enough to allow identification from the picture alone, a photograph of a egg mass and accompanying habitat are invaluable additions to a specimen, and taken together, will almost guarantee correct identification[1].

5. **Collect some**. Egg masses are typically short-lived and often impossible to find again, even if they are marked. If it is essential that you identify eggs to species, the most certain way to do so is to hatch some[2,3]. Typically, only a few (10 -20) are needed to ensure a good sample of tadpoles. If eggs are to be preserved, collect a large enough sample so that the typical form of the mass can be identified, and try not to deform the sample during collection. Transport them carefully – avoid shaking or jarring – and preserve then as soon as possible[2,4].

[1] see Photography section
[2] see Containers and Transport
[3] see Raising Tadpoles
[4] see Collection and Preservation

Tip: Do not assume that just because you hear or see frogs at a breeding site, they are responsible for the eggs you find. Pacific tree frogs, for example, are the most frequently heard frogs at breeding sites they share with spotted, red-legged, and Cascades frogs, as well as western toads.

Identifying Tadpoles

Tadpoles can be the most difficult life stage to identify: They are quick, delicate, and variable in color and appearance. The best way to identify tadpoles is to use a method similar to that for identifying eggs:

1. **First**, use field guides to narrow the list of potential species to those occurring in your area. For convenience, Appendix 2 contains a list of species which occur in the project zone.
2. **Second**, further narrow the list by considering when each of those species breeds. This will tell you when tadpoles are most likely to be present at your site.
3. **Third**, examine your tadpoles. As mentioned elsewhere (see "Capture and Handling"), a jar is the best means of doing this. Compare your tadpole to the reference materials available (see the list at the end of this section), and see if an identification is possible.

Tips:

1. Tadpoles often change greatly in appearance as they age. Older, larger larvae are the easiest to identify. If you have young larvae you can't identify, you can revisit the site in a few weeks. However, the only way to be certain you will see older larvae is to raise them. The enemies of tadpoles are many, and the larval stage is where many frog species sustain their highest mortality.

2. Tadpoles often vary in color by location, habitat type, and temperature. Color and pattern are good general characters, but know that specimens may vary widely in appearance, so an identification should never be considered certain on the basis of color or pattern alone. Use physical features as well.

3. Be sure you are not trying to identify multiple species. Just because tadpoles are swimming together, or you catch them in the same net, does not mean that they are all one species. Trying to identify a mixed sample will make your job much harder. Besides using color and appearance, try separating tadpoles on the basis of size – in the West, many species have a short breeding season, and a given species' tadpoles are often roughly the same size.

4. Frogs are easier to identify than tadpoles. Still can't tell? Collect a few larvae and raise them (see "Raising Tadpoles"). Not only will it solve your identification problem, but it will give you an excellent insight into the appearance and life history of the species.

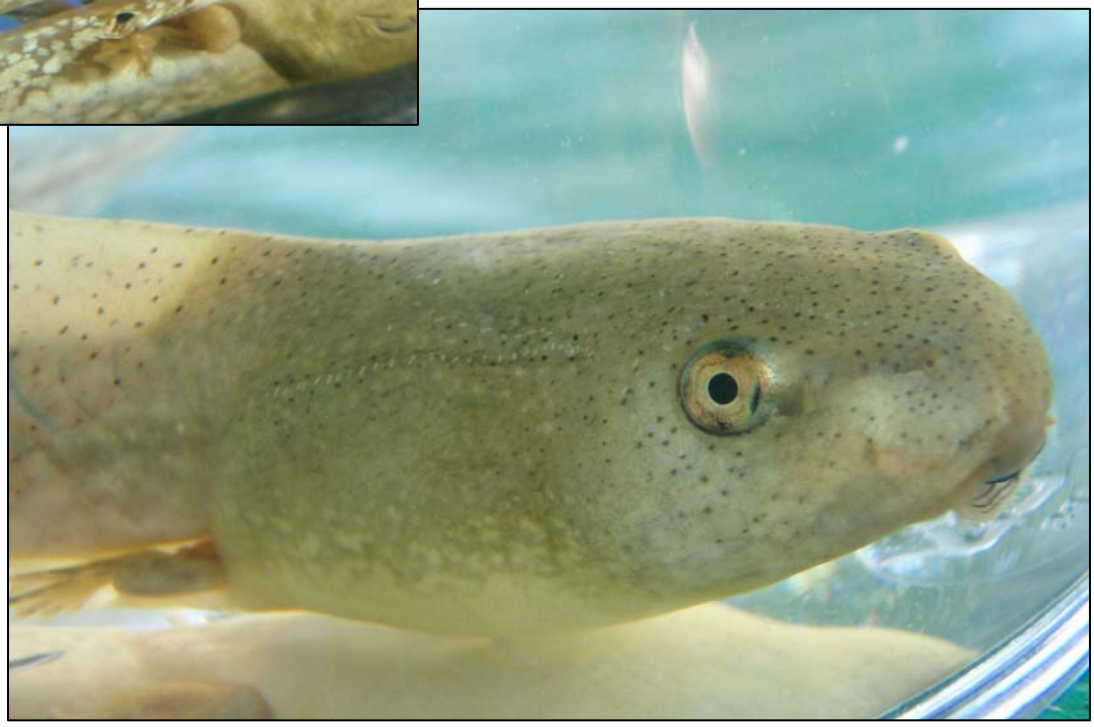
5. Collect a sample. Not only can tadpoles be identified definitively from a well-preserved sample, but such a sample serves as indisputable proof of breeding at a given area, which will benefit future conservation and management efforts.

6. Photograph. Because larvae are difficult to accurately photograph, taking photos of both the tadpole and its habitat will make it much easier for someone to

identify your find. In addition, specimens are more valuable when accompanied by photos of the animal and its habitat.

Some physical characters of tadpoles

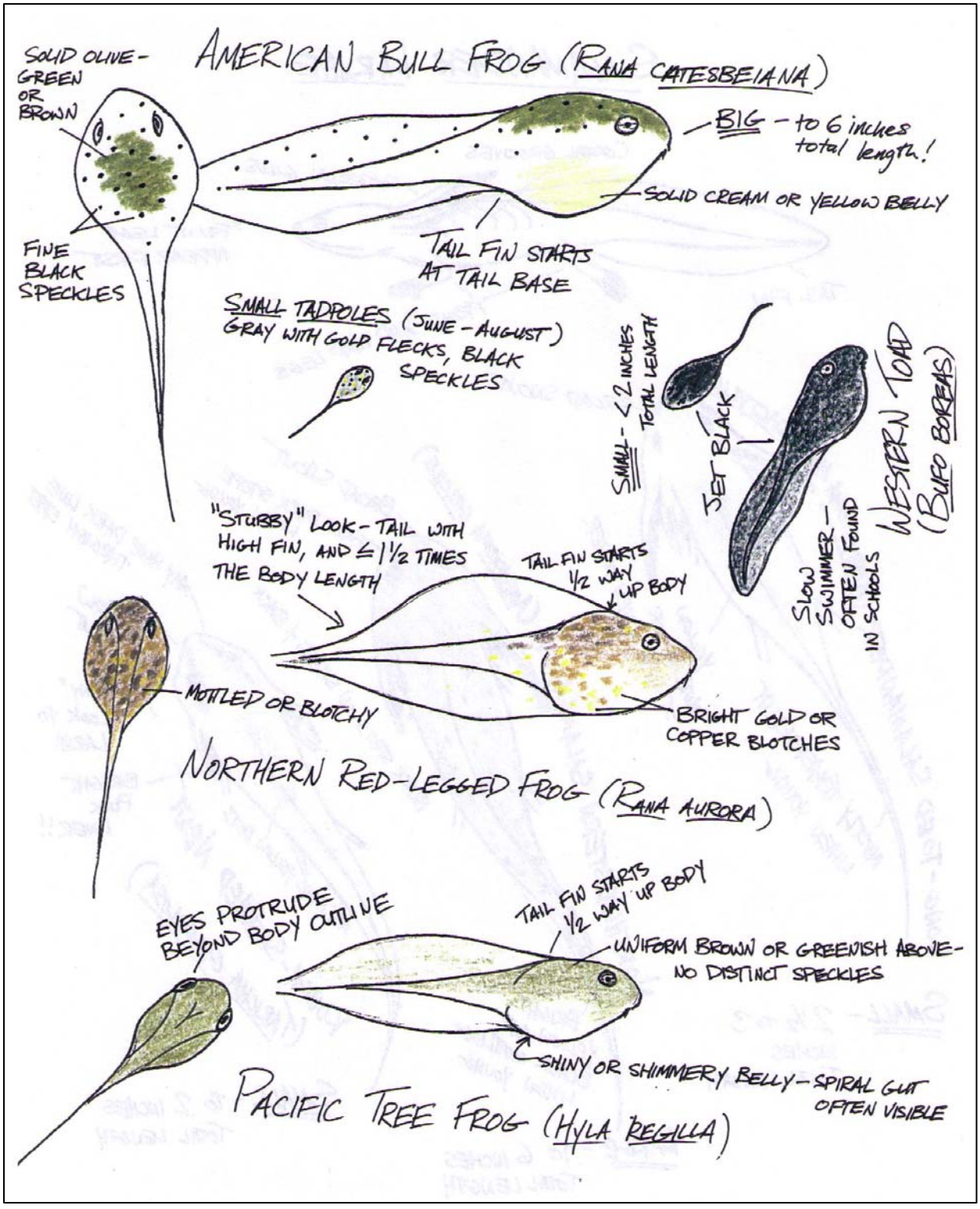
<u>Left</u>: Chromatophores (patches of pigment) in the tail of a tadpole.



<u>Right</u>: Side view of tadpole, showing

1) **Mouth (front),**
2) **position of eyes,**
3) **lateral line (on side),**
4) **insertion of tail fin (top).**

Field notes: A combination of color, pattern, and physical features are most useful for identifying live tadpoles. Making notes or sketches on the features that are *most obvious to you* will help you learn to identify tadpoles in the field.



Identifying Frogs and Toads

The adult life stage (the transformed frog or toad itself) of most frog or toad species is the easiest to identify. The following tips will assist with your task:

1. **Narrow the list**. Consult a reliable reference, such as a field guide, to determine which species are present in your area, and further reduce your list by considering the type of habitat you found the frog in. For example, a tailed frog is not likely to be found in a stock tank, and a Woodhouse's toad probably won't be in a cold forested stream. This list of potential species can be compiled ahead of time to make identification quicker and easier. Because most habitats in the West have relatively few frog species, this technique will greatly speed identification. For convenience, Appendix 2 contains a list of species which occur in the project zone.

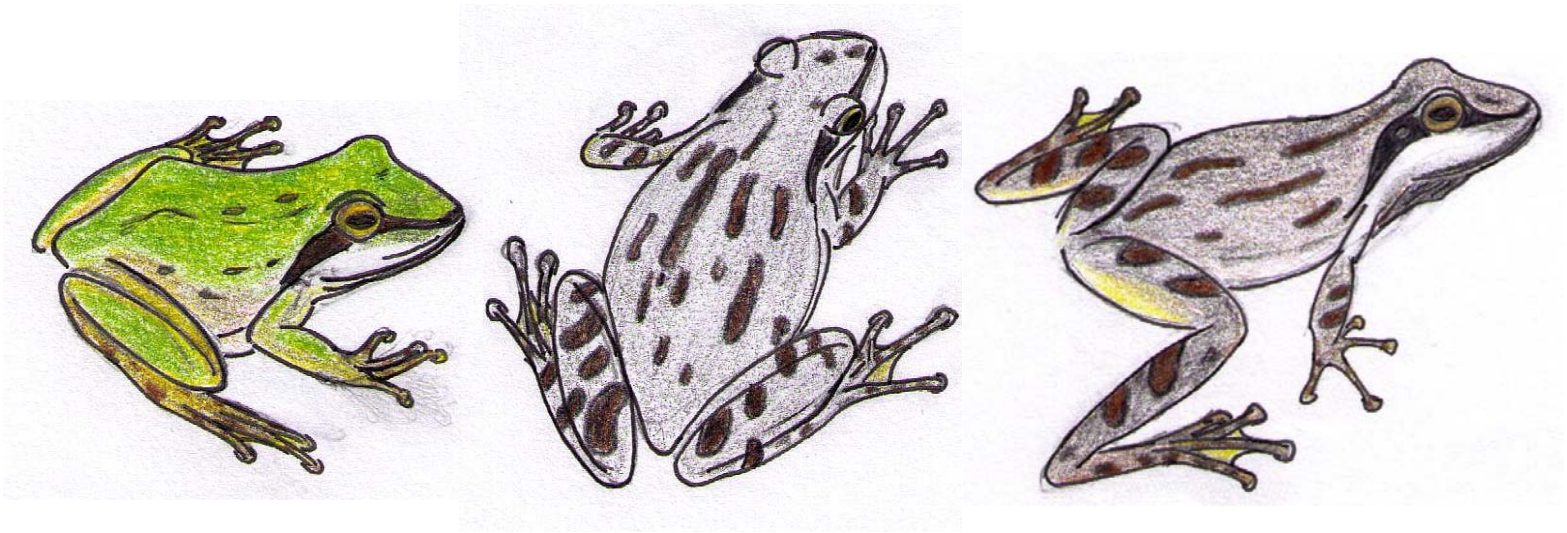
2. **Use obvious features** of your specimen to set it apart. For example: Tree and chorus frogs have toe pads (which let them climb vertical surfaces, including glass); toads have rough, dry, bumpy skin (and parotoid glands behind the head), and spotted frogs are yellow, orange, or red underneath. Therefore, a smooth-skinned, white-bellied frog, lacking toe pads, from a cow pond in Grant County, Washington, is quickly identified as either a Northern leopard frog or an American bullfrog, from a list of the species potentially present*.

   From this point, the presence or absence of less obvious features (*e.g.*, spotting pattern, dorsolateral folds, extent of webbing on toes of hind feet) would separate the two and confirm the species' identity.

   ***List of potential species:**
   Hyla regilla – tree frog (has toe pads)
   Bufo boreas / *Bufo woodhousii* – toads (rough, bumpy skin)
   Spea intermontana – "toad-like" (no smooth skin or long legs)
   Rana luteiventris – spotted frog (smooth skin, but with colored belly and legs)
   Rana pipiens – leopard frog (smooth skin, white belly)
   Rana catesbeiana – bullfrog (smooth skin, white belly)

3. **Photography** of adult frogs and toads is much easier than for egg or larval life stages, and a photograph from the proper angle (see "Photography" section), along with some notes on the frog's size and appearance (and especially a habitat photo!), will allow it to be readily identified.

Examples of color features used for identifying frogs. **Left:** Red *wash* on ventral surface, Oregon spotted frog. **Center:** Orange *wash* on ventral surface, Columbia spotted frog. **Right:** *Plain* or *immaculate* white ventral surface, Northern leopard frog.



Examples of color features used for identifying frogs. **Left:** Green dorsal surface and dark *eye mask*, Pacific tree frog. **Center:** Gray dorsal surface with *irregular* brown stripes, Pacific tree frog (top view). **Right:** Gray dorsal surface with *irregular* brown stripes and dark *eye mask*, Pacific tree frog (side view).

Field Guides and Keys

The following references are recommended for identification of frogs and toads over the survey area covered here:

1. **Field Guide to Western Reptiles and Amphibians** (Peterson Field Guides). Third edition, 2003. Robert C. Stebbins.
   The gold standard for western U.S. amphibians and reptiles. If you only have one field guide, this is the one. Covers all species in the survey area; detailed drawings are better than photographs at showing important identifying features; section on identifying amphibian eggs and larvae included; excellent species descriptions and life history notes.

2. **Amphibians of Oregon, Washington, and British Columbia**: A field identification guide. Lone Pine Press, 1996. C. Corkran and C. Thoms.
   The strength of this book is its photographs of multiple life stages of each species, as well as its good identification keys to amphibian eggs and larvae. This book does not include detailed life history information, but it is a very good reference for identification, especially when used in combination with #1. This book does not cover Idaho, but includes species found there.

3. **Amphibians and Reptiles of Montana**. Mountain Press Publishing, 2004. Even though this guide is for Montana, it includes many of the species within the survey area. Photographs of several aspects of each species or depicting multiple life stages are included, making it a useful reference.

4. **Amphibians and Reptiles of the Pacific Northwest**. University of Idaho Press, 1983.
   Strongly recommended. Although not as current as the previous three books (there have since been changes in aspects of taxonomy, distribution, *etc*.), this is the best book for those interested in really understanding Pacific Northwest species and their life history. If you want to do more than just identify amphibians, buy this book and read it.

5. **Amphibians of Oregon and Washington**. Seattle Audubon Society, 1993.
   A good brief reference to Oregon and Washington species. Only adult life stages are pictured.

6. **Amphibians of the Pacific Northwest**. Seattle Audubon Society, 2005.
   This is basically the revised/updated copy of the previous book. This is a fairly good reference. It has pictures of multiple life stages for most species, and it does cover all the survey area. Its biggest drawback is its lack of consistency in species accounts. Because of this, descriptions and life history information are good for some species but not for others. The format also makes it difficult for a beginner to use.

7. **Tadpoles of the United States and Canada: A Tutorial and Key**. R. Altig, *et al*. Available online at: http://www.pwrc.usgs.gov/tadpole/

   For those seriously interested in tadpole identification, this is a good reference to U.S. species. It covers a large number of species, most of which occur outside the survey area, so to use it successfully, one must be familiar with tadpole morphology and associated terms. However, the key is prefaced with a tutorial guide to tadpole morphology and terms, allowing the user to learn what they need in order to use it successfully. Nonetheless, identification of species may take some time, especially for the beginner.

8. **Photographic Identification Cards for Idaho Amphibians**. C.R. Peterson and H.J. Fabian. Available online at: http://www.isu.edu/~petechar/idar/amphib.pdf. These cards show specimens from Idaho, and include photographs of useful identifying features for each species.

Other Resources:

1. Dr. Charles Peterson is the recognized authority on Idaho reptiles and amphibians. He is the Curator of Herpetology at the Idaho Museum of Natural History. He can be reached at:

   Dr. Charles Peterson
   Dept. of Biological Sciences, Idaho State University
   Campus Box 8007, Pocatello, ID 83209
   Phone: (208) 282-3922
   Email: petechar@isu.edu

2. If desired, I will identify any amphibians or reptiles found during the course of this project. Please contact me prior to shipping any preserved specimens or living material. I can be reached at:

   Chris Rombough
   PO Box 365
   Aurora, OR 97002
   Phone: (503) 989-0031
   Email: rambo2718@yahoo.com

4b. Capture and Handling

Frogs and Toads

Capture

Most frogs and toads found during visual surveys are fairly easy to catch. Toads, being the slowest, can simply be picked up if on land, and easily plucked out of the water by hand or dip net. Small frogs, such as tree frogs and the juveniles of most species, can be captured by hand (or scooped up with a small jar) if on land, or with a dip net if in the water. The most difficult frogs to catch are large adults of aquatic or semi-aquatic species, such as spotted, leopard, or bull frogs. Spotted and leopard frogs in the water or on the bank may be caught during the daytime by slowly, slowly creeping (or wading) up to the frog until you are close enough to grab or net it.

Top: Frogs on the bank or on logs must be caught by hand.
Bottom: Frogs in deeper water can be netted.

By hand:

To catch a frog by hand, a fast grab should be aimed at a spot just in front of its snout, which will typically result in your getting the frog at mid-body when it leaps. DO NOT slap your hand down flat – you will squish it. Instead, cup your hand over the frog to trap it, then curl your fingers inward around the frog to secure it before you lift it up. Hand-catching a frog in the water is similar, except that when the frog is floating in the water, you grab for a point just in front of the frog's eyes (this works best if the frog is facing you), and "follow through" – continue your grab past the frog, pushing the frog against your hand and giving you time to close your fingers around it before it gets away (several inches is usually sufficient). Netting a frog on land or in shallow water (water less than the frog's height – i.e., if it is sitting on the bottom) is rarely successful.

With a net:

To net a frog floating in the water, you will be most effective if you approach the frog from the front (facing it). Move very slowly, just as you would if you were trying to grab it by hand. Hold your net with your left hand loosely holding it near the front, and your right hand tightly gripping the back of the handle, with your right arm (and thus the net) pulled as far back as you can reach. When you release the net, shove it forward as fast as possible with your right arm, letting the handle slide through your left hand until you have the net under the frog. Then, lift rapidly up with both hands to trap the frog inside. Gently shake the net bag to prevent a frog from getting a stable footing and jumping out of the net before you can grab it. When netting a frog, aim for a point six inches or so below the frog's nose (frogs often back up quickly before they dive forward, though it typically happens too fast for you to see it).

Netting a frog

Top: Hold net with left hand wrapped loosely around handle and right hand gripping base of handle. Pull the net as far back as possible.

Center: Push right hand forward, thrusting net through left hand and into the water beneath the frog.

Bottom: Use left hand to lift net straight up out of the water and trap the frog inside.

Reverse view:

There are differences in "catchability" between species. Spotted frogs are the least wary and easily captured during the day, while adult bullfrogs are extremely wary and almost impossible to catch by hand during daylight hours. In general, large adults of most western frog species are most easily caught at night. After dark, they are both more active and permit much closer approach. Any survey that wishes to accurately sample adult frogs should be (at least partly) conducted at night.

At night:

To catch frogs at night, the same capture methods are used (as are employed during the day), except with the aid of a light. The light helps you find frogs (their eyes have a reflective layer that shines when illuminated) and sneak up on them (by concealing your movements). Either a headlamp or a flashlight may be used, as long as you stay behind the light. Do not move in front of it until you actually grab for a frog, or it will see you and escape. The light itself should be bright enough that you can see a short distance ahead of you, and "shine" the frogs, but if it is too bright, it will scare the frogs away. (No spotlights or LED Maglites). A "spot" type beam is better than a "flood" light – it is more accurate and scared fewer frogs. A yellowish-tinted light is better than a bright white or bluish-tinted one. Avoid shining your light anywhere but on the exact spot you are searching. Waving a light around will scare all the frogs. Also, resist the temptation to search too far ahead – walk slowly, and keep your light a few yards ahead of you. If you shine a light on a frog from too far away, it will dive.

The moment you see a frog, hold your light on it. Approach a frog from the front (head-on, if possible), so that your light is in both its eyes. Hold your light steady and do not wobble it or move it off the frog (it will dive) until you grab. Grab as described above, but avoid loud noises, splashing, or flailing – it will scare frogs away. The best time to go night "frogging" is from an hour or two after dark until the wee hours of the morning.

Net frogs from underneath, scooping them up in the net bag.

Handling

The first and most important rule of handling frogs is to treat them like fish. Frogs have moist, permeable skin that rapidly absorbs many substances. NEVER handle them with dry hands, and always make sure your hands are **clean**: **no soap, lotion, sunscreen, and especially, no bug spray!!** These will all injure or kill a captured frog, though often you will not be around to see it, since you will have released the frog and moved on. With this mind, the second most important thing to remember is that frogs have no ribs - squeeze one around the middle too tightly, and you will squish and kill it.

The proper way to handle frogs is as follows:

Large frogs (bullfrogs, adult leopard and spotted frogs, etc.) should be gently but firmly held around the "waist". Wrap one hand around the frog's hind legs, right at the point where they join the frog's body. A gentle grip here will prevent the frog from getting its legs into a position to jump away. Place your other hand under the frog's body to support its weight. Never let a frog hang from your hand, dangle upside down, or twist and flop around. This will cause it serious injury.

Many frogs will go limp when grabbed or after they have been held a few seconds. This is a trick!! If you loosen your grip, they will be gone before you can say "oops!"

The proper way to hold large frogs: around the waist, supporting the body (with palm of hand, *left*; and fingers of same hand under frog's chest, *right*).

Small frogs (tree frogs, juveniles of all species, etc.) are best handled by gently but firmly grasping them by the base of a hind leg. Hold it as close to their body as possible, and support the weight of their body with your other hand or some other surface. Don't grab them by the body – what is a light and gentle grip for you is a crushing pressure on their lungs and internal organs.

An alternate way to catch small frogs, especially for transfer to a container, is to just trap them in your hand, wrapping your fingers around them and confining them inside. Don't open your hand, though. The "open hand" technique is for small children, and usually ends quickly with the escape of the frog. Falling from the open hand of an adult to the ground is a long way for a small frog, and often results in their injury.

Keep handling times short to avoid stress or injury to the frog. Remember, the best method for examination of a frog is a jar. You can look at the frog as long as you like, without the harm that comes from holding it in your hand.

Top: Small frog held at the base of the hind leg, with its body supported by a finger.

Bottom left: Small frog held at base of hind leg, with its body supported by ground.

Bottom right: A jar is the best way to handle frogs for examination, especially by groups of people.

Photo by Roger Ross Photography

Measuring frogs

The standard measurement of a frog's size is the length of its body, termed the "snout-vent length" (SVL), or the distance from the tip of its nose to its vent. This distance is always measured along the frog's belly. To measure a frog, hold it gently against a wet plastic ruler. Placing your thumb on the frog's back, press it **gently** against the ruler so that it is stretched out, not sitting up. This way you get a more accurate measurement of its size, but **DO NOT SQUASH IT FLAT!!!**

Remember, frogs are soft, have no ribs, and are easily injured, especially if they are struggling. When in doubt, remember – less pressure is better than more.

When measuring frogs, use gentle pressure to keep from hurting them. Photos: Left: Laura Trunk. Right: Rob Konkle.

To weigh frogs, place them in a plastic ziplock bag and use an appropriately sized spring scale (see "Survey Equipment"). Be sure to subtract the weight of the bag.

Tadpoles

Tadpoles often blend in with their surroundings.

Capture

Finding larvae is often more difficult than capturing them. Larvae of most frog species are wary, and will rapidly swim under rocks or silt, or into thick patches of weeds, if they sense an observer coming. A stealthy approach will often reveal tadpoles in a place you thought held none. Tadpoles of all types may simply be scooped up in a dip net.

For small, recently hatched larvae, which often stay close to the substrate in shallow water, a cup or small jar may be used to scoop them up without injury. Rather than chase them with the jar, it is best to place the jar in the water and gently herd the tadpoles into it. A small aquarium dip net works very well for catching tadpoles, but remember that mesh, even fine mesh, is abrasive to the skin and mucous covering of small larvae, and is thus not as satisfactory as scooping them up "untouched" in a jar.

Large, fast tadpoles will often require a careful sneak-up and rapid scoop with a net, before they make it to cover or deeper water. Often, sweeping your net quickly through a patch of weeds (a preferred hiding place) will capture some larger, faster larvae. In open water, aim your net sweep in front of larvae (unlike fish, they don't change direction very well), or bring your net up under them from beneath.

Handling

Don't. That's what jars are for. In a sturdy, water-filled jar, a tadpole can be examined closely or even passed around to a group, without injury.

Do not leave the jar in the sun for any length of time – your tadpole will rapidly overheat and die. Also, remember that tadpoles breathe with gills, so even if a jar of tadpoles is kept shaded, they will eventually run out of oxygen unless fresh water is added.

If it is absolutely necessary that tadpoles be examined in a net, it should be done so by gently cupping the net in shallow water, so that the tadpole is kept at least partially submerged. Act quickly - your goal should be to get the tadpole back in the water as fast as possible.

A jar full of water is the best way to handle and examine tadpoles without hurting them. Photo by Roger Ross Photography.

Eggs

To examine eggs out of water, use a container that is large enough to hold both the egg mass and a layer of water all around it (so that it is floating, and not squished against the container sides). To 'catch' an egg mass, place the container in the water, fill it and then gently lift it from underneath the egg mass, so that the mass stays in it. Don't lift too fast, or the mass will spill out over the sides. Remember that eggs, like larvae, do need oxygen, so don't keep them in the same water for too long, particularly if the mass is large. Also like larvae, don't leave a jar of eggs in the sun. Don't lift egg masses with your hand or net – most egg masses are very soft, and they will just squish and fall apart.

A jar full of water is the best way to handle and examine frog eggs.

4c. Containers and Transport

Frogs

For weighing frogs, a plastic zip-lock bag works best. They are easy to close, come in a variety of sizes, and are cheap, so that they can be thrown away (or now, recycled), and a new bag used between frogs or sites.

For holding frogs more than a few seconds, a plastic jar or container is ideal. It must have air holes, so captives can breathe. A layer of wet moss, leaves, or paper towel in the bottom will help keep captives moist and give them something to hold on to. Do not keep adult frogs in a jar full of water; if they are kept in deep water with no way to get out, some forms will eventually drown. Keep jars out of direct sunlight. For transporting frogs, pack jars/containers securely in a cooler (to prevent shaking and injury to the frogs). On warm days, a bit of ice can be added to the cooler, to prevent captives from overheating. In general, cooler is better than warmer, but do not place frogs' containers directly on ice! First, wrap either the ice or the frogs' container in a towel or some other insulating material, so that the frogs are not injured by the cold. Do not crowd frogs in containers, and do not mix animals of different sizes, as the smaller animals are likely to get eaten.

When keeping frogs in jars, give them water, but don't make it so deep that they can't sit on the bottom. Photo by Roger Ross Photography.

Tadpoles

Tadpoles may be transported in a jar, bucket, or similar container. A deep container is better than a shallow, wide one, since it will minimize shaking to the larvae.

Young tadpoles will only breathe the oxygen in the water; for short trips, the container can thus be filled to the brim and tightly sealed. Without an air space in the container, the water will slosh a lot less, and the tadpoles will arrive in much better shape. Do not crowd tadpoles. In a sealed container, without supplemental air, figure that 2-3 inches of total tadpole length (this can be one big tadpole or a bunch of small ones) per gallon of water will survive for approximately one hour at 50°F. Stop and check your tadpoles frequently. Opening the container and gently splashing the water's surface or adding fresh water will help replace lost oxygen.

Cooling: Unless collected during very cold weather, try to keep frogs, larvae, and eggs at 40°F or above.

For longer trips, the use of a battery-powered aerator (available at sporting goods stores or bait shops) may be necessary. Adjust the bubbles to a very small size to prevent injuring delicate larvae. If you have to, wrap the air stone in cloth or fasten it near the top of the container.

For older tadpoles, an air space (between the water's surface and the lid) must be left in the container. As tadpoles mature, they begin to gulp air from the surface and will drown if prevented from reaching the air. For carrying older larvae on trips of more than a few minutes, air holes should be made in the container lid, as well.

Finally, remember that tadpoles' metabolic rate, and consequently their rate of oxygen consumption, is dependent on temperature. By lowering their body temperature, you will reduce their oxygen requirement, and extend the life of their air supply. Larvae are therefore best transported in a cooler with a little ice, in the same manner as adult frogs. Be sure to pack containers securely to prevent sloshing or spilling. Again, do not crowd tadpoles.

Eggs

Eggs are best carried in a completely filled (i.e., with no air space – fill and seal it underwater if you can), tightly sealed container, with a leak-proof lid. Like frogs and tadpoles, eggs transport best when cooled, at least for long trips. Be careful not to overcrowd – eggs use up oxygen faster than you might think. Plan on a general estimate of: 50 eggs per gallon of water @ 50ºF will last for about 1 hour. As with tadpoles, eggs carried on long trips may require periodic aeration of their water.

Do not put frogs, tadpoles, or eggs in fresh tap water – chlorine in the water will kill many forms. Instead, use pond, distilled, or 'spring' water.

Transport eggs in jars filled completely with water, without air space. This keeps them from sloshing around and being damaged. Refresh water as needed to maintain oxygen levels.

4d. Photography

Frogs and toads present interesting subjects for photography. Primary obstacles to successfully photographing them include their small size, their speed, and their moist, reflective skin. These obstacles can be overcome by: 1) using the right camera, and 2) using the right photography techniques for these animals.

1. **Camera**. The most useful camera for survey work of this type is a small digital single-lens reflex (SLR) camera which is shock- and waterproof, with an automatic zoom and a macro setting. Two good cameras are the Olympus Stylus and Panasonic Lumix, both of which are available in shock- and waterproof models. These cameras have a number of pre-configured settings for different situations, including an 'auto' setting, which does most of the work for you. The following instructions are for the digital SLR cameras just described.

   In order to take useful pictures of frogs and toads, the user needs to be able to switch back and forth between normal and macro mode. Almost all photographs of frog and toad life stages will require a macro setting. The best setting for this purpose is the autofocus "zoom" macro setting, which has a wider focal range than the most close-up ('super macro') setting on the camera. (This last setting typically has a very narrow focal range, which is too short for most frogs and toads, and requires a little more practice to become good at.)

   The author strongly recommends that a surveyor **practice** using the macro mode on their camera. Take some experimental photos. Learn the optimal focal range, and experiment with different resolutions, shutter speeds, and amounts of light. These are the most important factors, and taking a few minutes to learn them BEFORE you go out in the field will make the difference between valuable reference photos and garbage.

2. **Techniques**. The primary purpose of voucher photographs is to serve as a means of identification. Because of this, they need not be artful or artistic. Your goal in taking a voucher photograph is to illustrate the animal's identifying features as clearly as possible. To accomplish this, the following recommendations are made for each life stage.

Photographing Frogs

Most visual identifying features of adult frogs and toads are found on the dorsal and ventral surfaces, as well as the sides of the head. Therefore, the three most important photographs for identification are the dorsal, ventral, and side views, as follows:

Container Photography. The best containers for photographing adult frogs and toads are generally too high for them to jump out of, but with a wide enough opening to allow the photographer to get a good picture. Avoid narrow containers, containers with highly reflective or strongly curved sides (*e.g.*, jars), and those with sharp corners (like a box or aquarium), which can reflect or absorb your flash and prevent you from getting a good photo.

For beginning photographers, a small Rubbermaid tub (3 gal.) with a thin layer of non-reflective material (moss, grass, wet paper) is a good container.

1. **Dorsal view**. A view of the frog from directly above – or offset by just a few degrees in order to see details of the skin. Such details include color, patterning, and features such as dorsolateral folds, dermal tubercles, and parotoid glands. If the subject is slow moving, this shot can be easily made *in situ* (in place), by placing an object in front of the animal to block its movement (a hand, notebook, *etc*.) Focus on the subject, and then take the picture when it stops moving for a second. For faster-moving species, (*e.g.* leopard frogs), the animal will have to be restrained (see "Capture and Handling"), and gently held on a moist surface while the photograph is taken. Alternatively, you can photograph an active frog or toad from above by placing in a container.

Dorsal view. Pacific tree frog (*Hyla regilla*).

2. **Side view**. The most important area to picture with this view is the side of the head, since this is where most identifying features (eye mask, tympanum, parotoid gland, etc.) are found. For slow-moving species, the side view can often be obtained in the same manner as the dorsal view (above). Furthermore, the two can often be combined in the "3/4 view" (see below). For fast or active species, this shot is obtained by holding the specimen in the hand (be sure to support its body) or by photographing it through the sid

Side view. Pacific tree frog (*Hyla regilla*).
Photo by Tom Brandt.

3. **Ventral view**. This view is not always required, but is important for identifying species in which ventral color or pattern are important characters (*e.g.*, spotted and red-legged frogs). Taking this shot while holding a specimen in one's hand requires very careful handling, to avoid injuring the frog. The frog should be held in the proper manner (around the waist; see 'Handling'), and then carefully turned over, while its body is supported by your other hand. Keep the frog's body supported on something while it is upside-down – don't let it hang backwards, or you can injure it. Work quickly to get your photo before the frog begins twisting and struggling to right itself.

   The best and easiest way to get this photo is to cup the frog gently against the side of a water-filled container, and photograph it through the side. See photo.

Ventral view. Frog is held gently around the waist, with its body supported on a wet cloth.

Ventral view. Frog is gently cupped against the side of an aquarium.

4. **"3/4 view"**. With a little practice, the dorsal and side views can often be replaced with a single shot that combines the two surfaces. The idea here is to get a picture that shows features of the frog's head, back, and sides. This shot is focused on a point three-quarters of the way up the frog's side, and includes details of the frog's head, as well as its side and back. To keep the frog's head in focus, this shot should be taken by either:
    1) directly facing the side of the frog, or
    2) looking slightly backward along the body from the head.

Be sure that your focal range includes both the head and body, so that important features are not blurred out. The ¾ view can be slightly more difficult to get than the dorsal and side views, because your position places you directly in the frog's vision. This makes it more likely to jump away from you during an *in situ* shot, and because it requires the frog to sit in a more or less natural position, it is difficult to take while the frog is being held. Nonetheless, with a little patience and practice, one can master the art of getting a photograph that is both useful and attractive.

Examples of the "3/4 view": Top and bottom right: looking back along body from head. **Top and bottom left:** side views rotated up to show features of back.

A frog's wet skin reflects light, causing glare which may obscure important features.

Using Flash

One of the most important aspects of photographing frogs is the use of flash.

Because frogs have moist skin which reflects light, improper use of a flash gives frogs a "shiny" look, distorts their color, and obscures their pattern. Properly used flash will reduce glare, enhance color, and give sharper photos of small animals.

You will get much better photos if you learn when to use and when not to use flash. The three most common situations where flash is needed are:

1) photographs taken in dark situations (like at night),
2) close-up shots of small objects (macro shots), particularly if the subject is moving or is in dim light, and
3) when shooting into strong, angled light where a fill flash is needed to eliminate dark shadows.

1. In the first case, see if your camera has a 'night' mode, which adjusts for low light and may give a better exposure than the automatic flash setting. If the setting isn't pitch dark, but just dim, you may have better results with the 'red eye elimination' flash than with the automatic setting. If you do have to use the full flash, try angling the camera so that the subject is evenly exposed, eliminating shadows. For example,

Night time photo taken using a flash.

2. In the second case, flash may be needed to prevent a blurry photo. This is most likely to happen in low light conditions, or when using the macro setting to photograph an animal that is very small. To prevent glare or "burnout" from the flash, try backing up and using the zoom setting from farther away, so you can aim the flash elsewhere, and use it to illuminate the subject without being directly on it. Alternatively, set your camera to the highest possible resolution, and take the picture without zooming in – the frog may look small on the screen, but you will still get a sharp image when you enlarge it on a computer.

If you do attempt to photograph a small animal (using the macro setting) in low light without a flash, both the camera and the subject will have to be very still. Hold the camera frame against something to prevent movement, and depress the button very carefully. Because of the low light and macro setting, the shutter speed will be a lot lower, and in some cases, it will take the camera several seconds or more to acquire the shot. If you move the camera at all during this acquisition period, you will get a blurry photo. Holding a camera very still for this type of shot is not as easy as you might think; it is a skill you might want to practice.

Close-up shot of a small frog without using flash. The picture is blurry because the shutter speed is too slow to handle small movements.

Same frog, photographed using flash. The picture is clear because the higher light allows the camera to use a faster shutter speed.

3. Not much can be done about bright, harsh environmental lighting (i.e., direct afternoon sunlight) when photographing frogs *in situ*, except for:

a) adjusting the camera angle to minimize glare,
b) using a fill flash (see above), or
c) blocking or diffusing light with a nearby object (your body, a thick clump of grass, *etc*.). Take care to avoid putting the subject in deep shade.

Too dark. This frog was photographed in shade without using a flash. The picture is too dark to be really good for identification.

Too bright. This frog was photographed in strong, angled sunlight without using a fill flash. The picture has harsh shadows as a result.

Some examples of camera angle and flash. The angle at which the subject is photographed can make a big difference. In the first case pictured here, the slight adjustment of camera angle reduces glare by allowing light to penetrate into the water.

In the second case, the photographer is facing into the light, which causes the side of the frog facing the camera to be shaded and appear dark. By moving so that the light is coming from behind the photographer, the subject is illuminated. The use of fill flash helps eliminate harsh shadows caused by strong light coming from a single direction. The fill flash is aimed at a point away from the frog, to reduce glare.

Photograph of a spotted frog in water. The light reflects off the frog and the water, causing glare.

Same frog, photographed from a slightly different angle. Fill flash is used to "surround" the frog, so that light comes from all directions.

Photograph of a red-legged frog without flash. The light is coming from in front of the photographer, and the contrast makes the frog look dark.

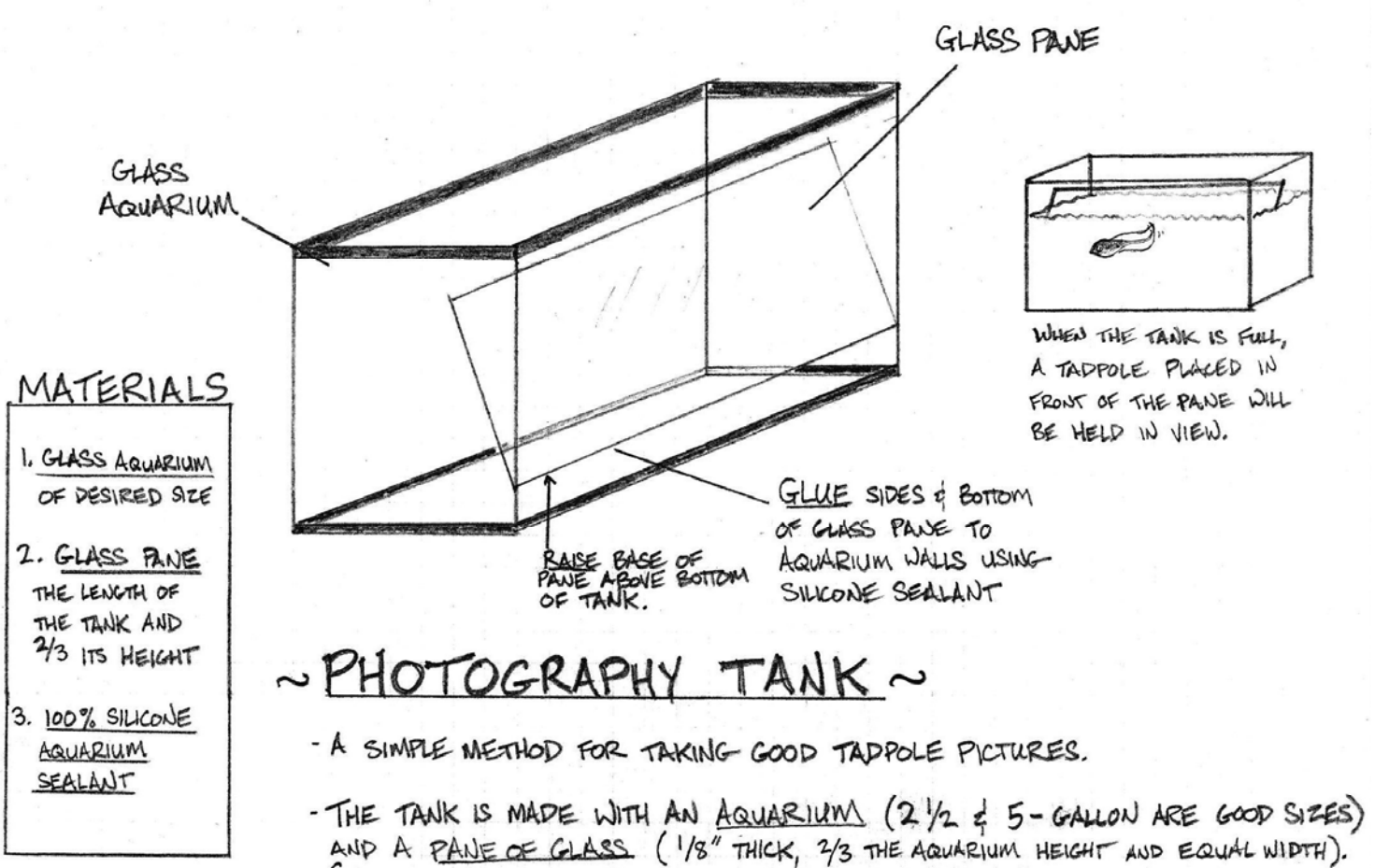
Photograph from the opposite side. The light is now coming from behind the photographer. A fill flash is used to eliminate harsh shadows.

Photographing Tadpoles

Tadpoles are difficult to photograph. They are very active, highly reflective (wet and shiny), and do not last long out of water. There are two ways to photograph tadpoles: 1) in a photography tank, or 2) on a wet surface.

1. **Photography tank method**. By far, the best way to photograph frog larvae is with the use of a photography tank. This is simply an aquarium with an angled back pane that pushes a tadpole into the camera's focal range.

   The simplest way to make a photography tank is to take a small glass aquarium (2 – 5.5 gal size) and fasten a glass pane of equal width to the inside of the tank. The pane should be at least 1/8" thick to prevent easy breakage. (Plexiglass or Lexan can also be used for the inside pane, but stick with a glass aquarium, since the plexi- or plastic ones, while much more durable, also scratch easily.) The pane should touch the aquarium side about halfway up the tank, and angle away from it at about 45°. The steeper the angle, the more closely a tadpole will be held to the front of the tank. Attach the pane to the tank (along the sides and front) with 100% silicone aquarium sealant. Use painter's tape to hold the pane in place until the sealant cures (about 48 hours).



To use a photography tank, simply fill the whole thing with water, place a tadpole in the front portion and photograph it when it stops swimming. (This will happen faster if the observer is still and quiet. Avoid sudden movements and loud noises, which will scare the tadpole.) In most situations, a light colored, opaque backing will greatly improve the quality of the photo. Try taping a piece of paper to the outside rear wall of the aquarium. As you might guess, camera flash will be of little use in this situation. Strong or direct light on the tank will cause glare. For the best photographs, the tank should be illuminated through the front, from behind or slightly above the photographer. Illumination from most other angles will make the tadpole look dark, although diffuse light from above can be used to supplement lighting from behind and give a better picture. Distilled or clean creek water will yield the best results in this setup. Avoid using dirty or muddy water, as well as water that is heavily stained with tannins.

Why not a jar? Jars are difficult containers to photograph tadpoles in, because their curved sides distort light, and hence tadpole proportions. The result is a photograph that may look pretty cool but is often difficult to identify to species. If you have to use a jar, thin-walled plastic ones generally work the best.

The curved walls of a jar distort proportions, which can make a tadpole difficult to identify. The best type of jar for photography is a thin-walled, rigid plastic jar (pictured here).

The flat sides of a photography tank do not distort proportions. Plants or grass can be placed in the tank to make a more interesting setting, if desired.

2. **Wet surface method.** This is the method typically used in field surveys, since carrying a photography tank is laborious and time-consuming. The wet surface method is fast, easy, and requires no specialized equipment, but photographs are typically of poor quality (due to movement or reflectivity of larvae) and the handling required to obtain them is usually fairly hard on the larvae – to the point where delayed mortality occurs and larvae might just as well have been collected as specimens anyway, especially with beginning or careless observers (see below). In addition, for most surveyors, the wet surface method is only worthwhile on larvae ≥1.5 inches in total length. Below this size, photos are usually too poor for accurate identification.

What price photography? On many occasions, the author has seen both amateurs and 'experienced' biologists roughly handle animals for the purpose of getting photographs. After a prolonged photography session, the animal may crawl or swim weakly away, only to die shortly afterward. Even more sadly, the photographs thus obtained are often not very good.

Therefore, in the case of small or delicate animals, or if inexperienced or careless handling is going to be the rule, it is sometimes better to just collect a small sample of larvae as voucher specimens. The animals can then be killed humanely, without prolonged suffering, and the resulting specimens will be much more useful for identification and scientific research than some poor quality photos. (See "Collection" for methods.)

Nonetheless, the wet surface method is best performed as follows:

1. Ready the camera with the proper position and settings (to reduce the amount of time the tadpole is out of water – they breathe with gills, and suffocate in air).

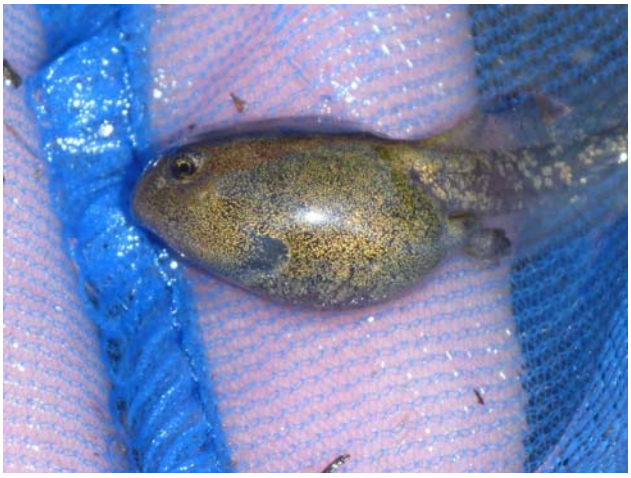
2. Then, gently scoop the tadpole out of the water and lay it flat on a moist background. The mesh of a dark-green net or soft wet cloth (supported from beneath by a cupped hand) is best. Your hand can be used, but be sure it is wet and clean (see "Handling" section), and because of the color, it does not make as good of a background as a dull (green, brown, gray, etc.) surface (due to color saturation of the digital image). NEVER put a live tadpole on sand or soil – the soil granules will abrade its mucous covering and skin and will injure it. A ruler or other object can be placed in the photo for scale, if desired, but this is rarely necessary (or easy, in the time and working conditions available), and it is usually better to just record sizes with your accompanying notes.

Above all, your goal should be to take your photo and get your tadpole back in the water as quickly as possible.

Some examples of the wet surface method:

Left: tadpoles on the mesh of a net. Note that net is being supported by hand to provide a flat surface (top photo).

Right: tadpoles in hand (top and middle), and on a wet leaf (bottom). Note that hands are wet and no effort is being made to grasp tadpoles; they are simply supported on a wet surface.



Compare the photographs here with the picture on page 52, which was taken using a photography tank. The superior quality of a tank photo really is worth the effort.

Photographing Eggs

Frog and toad eggs are not as difficult to photograph as one might imagine, but some effort is required to get voucher photographs that are useful for identification. The primary obstacles to photographing egg masses are their texture (egg jelly is typically soft and amorphous, and distorts when touched) and location (underwater). Most species' masses are very difficult to photograph *in situ*, because of water depth, water clarity, or obstructing vegetation. In addition, their wet surface is extremely reflective out of water, and as mentioned, most will distort if touched or handled, altering the original shape, which is one of the most important characters for identification.



Removing egg masses from the water deforms them (below, left and center). The resulting photo has little value for identification. The proper way to photograph eggs is floating in water, using a light background if necessary (right).

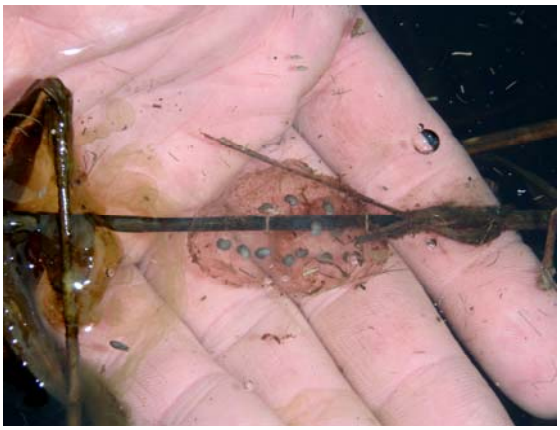
The best way to photograph an egg mass is in the water with the use of an artificial backing, such as a white plastic card or container of appropriate size (cup or margarine tub for small masses, 1 gal. bucket for larger ones). A measurement grid (*e.g.*, 1 cm^2 or 1 $in.^2$) drawn on the card or bottom of the container with a permanent marker is helpful in establishing scale. The card or container is then slid under the egg mass, and the water allowed to become as still as possible (drips or ripples will ruin your photo) before the picture is taken. The use of flash may be necessary to penetrate dark or stained water. Try to angle the flash away from the egg mass itself to reduce reflection. Small egg masses may be carefully scooped up in a cup or jar (which must be filled with water to prevent their collapse) and transferred to an aquarium for photography.

The goal is to photograph an egg mass which is floating (or sitting) freely in the water, so that it maintains its natural shape. **The most important identifying features in an egg mass photo are:**

1) The **shape** and **size** of the mass, and
2) The **location** and **position** of the mass.

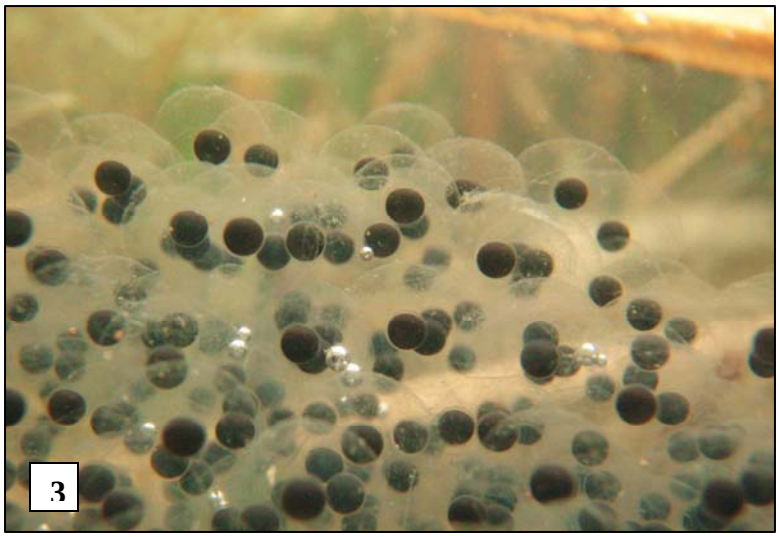
From these, if they are depicted accurately, the origin of the mass can usually be determined. Additional details, such as general location (distance to shore, water depth, attachment type, etc.) are best recorded in field notes or illustrated with a habitat photo.

Egg mass, photographed in water using a hand as a light background.



The same egg mass. Fill flash is used to remove the glare on the water's surface and make the photo clearer.

Egg mass photography. The same egg mass looks very different if it is photographed out of water (**1**), in water from above (**2**), and in water from the side (**3**). Note that floating freely allows the mass to assume its natural shape and proportions, which are necessary for identification. Photos of the position (**4**) and location (surrounding habitat, **5**) of an egg mass are very useful when trying to identify it.



Habitat Photos

Photos of habitat are often as important as pictures of a species itself. They can aid species identification, assist in interpreting declines, illustrate environmental conditions, help with restoration, and more. If taken properly, a photo is worth a whole page of notes. When taking habitat photographs, two types of shots are useful: 1) general and 2) microhabitat photos.

1) **General habitat** photos depict the "typical" or average habitat in a survey area.
This may also be considered the dominant type of habitat in an area. For this reason, it is often best to wait until the end of a survey to photograph this, in order to get an accurate impression of what the dominant habitat type really is.

Think carefully when you take this photo. Don't just snap away toward the horizon – such photos are rarely useful. Also avoid broad panorama shots in which trees and hills are only visible as a thin, distant line. Resist the impulse to try containing the entire survey area in a single shot. Instead, select a piece of habitat that accurately represents the average conditions of your survey area, and photograph that. Make sure that key features are visible as such – for example, an oak tree should look like an oak tree, not a tiny twig. Avoid the temptation to photograph atypical conditions just because they are pretty. (For example, don't take a photo of the only patch of wildflowers in twenty square miles of dry grass and call it "typical".) Finally, make a note in your sheet or survey book as to the location of the photo, and any important aspects that are not captured in the reference image. You'll be glad you did.

General habitat: a sample of the "typical" habitat in a survey area.

2) **Microhabitat** photos show specific habitat features at the location in which an animal was found. They are much more limited in scale that those of typical habitat, and should attempt to accurately show the features which are most important to the given animal – cover, vegetation, water, etc.

There is no need to take a photo at every capture location during a survey of this type. Instead, choose a few sites that are typical of the majority of captures, and photograph them. Include in your notes the photo's location (or which captured/observed animals it corresponds to) and a description of important features outside of the photo's scope (*e.g.*, aspect, distance to water, distance to cover, etc.).

Microhabitat: the small "piece" of the habitat where a frog was found.

4e. Raising Tadpoles

Eggs or small larvae that cannot be identified at the time of discovery can be raised until they are large enough for accurate identification. The simplest way to raise eggs or larvae is in a glass aquarium, with sufficient light to promote algae growth.

Housing: a 10-gallon aquarium with a screen lid is the best choice for most species. A good location for the tank is in or near a window, but do not place it in direct sunlight, which will quickly overheat the water and kill your tadpoles.

Water: amphibians require non-chlorinated water. They may be kept in potable well water or distilled water, as well as water from the pond in which they were collected. If distilled water is used, adding a cup or two of water from the tadpoles' source pond will inoculate the aquarium with algae that the tadpoles can use as food (see below). When collecting pond water, be careful not to collect tadpole predators (water bugs, diving beetles, dragonfly larvae, hydra, etc.) with it! The water in the tank should be changed at a rate of 50% each week to prevent build-up of waste products (such as ammonia); as tadpoles grow, a 50% change twice a week is better.

Lighting: The best source of light is an aquarium strip light with a full spectrum bulb, such as ZooMed's Reptisun bulbs or a full-spectrum plant light for aquarium use. The light will promote the growth of plants and algae, which in turn will clean the water and provide food for the tadpoles. If using reptile bulbs, some ultraviolet-B (UVB) output is good, but do not use any bulb with more than a 5% UVB output. The light should be left on for at least 12 hours each day, but can be left on 24 hours a day, if desired.

Temperature: 70-75^{o}F is a suitable temperature for the larvae of most pond-breeding frog or toad species described in this report. If the room temperature is much below 65 ^{o}F, a reflector lamp with a 40-watt incandescent bulb, positioned over one end of the tank, will warm the water to the tadpoles' preferred temperature. Most of the species covered here grow most rapidly when they are allowed access to water in the upper 70s or low 80s ^{o}F for at least several hours each day.

Food: Tadpoles will not eat for the first several days after hatching. Following this, they can be fed fish food (high-quality goldfish or tropical fish food, such as TetraMin). Feed tadpoles daily, but only give as much food as they will eat in 30 minutes, to avoid fouling the water. If the instructions here are followed, the tank walls will grow algae, on which the tadpoles will also feed. In addition, algae-covered plants or sticks from the tadpoles' home pond can also be placed in the tank. The tadpoles will typically feed eagerly on these until they have consumed all the algae, at which point the plants or sticks can be replaced with freshly collected ones.

Adding eggs or tadpoles: Although an entire egg mass of most species can be easily hatched in a 10-gallon aquarium, much lower stocking densities are needed if tadpoles are to be maintained successfully. For native frogs, keep no more than 1 full-sized

tadpole per gallon of water (i.e., a maximum of 10 large larvae per 10-gallon tank). A good general rule of thumb is to keep "1 inch" of tadpole per gallon of water. It is best not to mix species, as they often grow at different rates and some (*e.g.*, spadefoot toads) are cannibalistic.

Transformation: As the tadpoles approach metamorphosis, they will lose their ability to swim and must be given a means to climb out of the water. Providing a floating piece of wood or bark will accomplish this goal. They may also be transferred to a tank with shallower water and an escape ramp made of wood or pea gravel.

Raising froglets: Recently metamorphosed frogs or toads may be kept in a terrarium with a layer of moist soil, peat moss, or pea gravel in the bottom. Provide a shallow water dish which they can easily get in and out of, and include moist hiding cover (such as leaves or bark, or crumpled wet paper towels) so that the froglets do not dehydrate. To increase humidity and prevent dehydration of froglets, the lid can be partially covered with glass or plastic. Be sure not to cover the entire lid, since the frogs need to breathe!

Froglets can be fed small ('pinhead') crickets, baby mealworms, or flightless fruit flies, all available at pet stores or through mail order suppliers (Timberline, Ghann's, Sunshine Mealworms, etc.). Alternatively, a heavy canvas or muslin sweep net can be used to collect small insects from grassy or weedy areas. When collecting insects, be sure not to collect from areas which have been recently sprayed with pesticides. Froglets may be fed daily, as much as they will eat. This will result in rapid growth to a size at which they can be easily identified.

4f. Collection and Preservation

Amphibians are traditionally prepared and stored as wet specimens, in contrast to mammals and birds, which are typically prepared and stored as dry specimens (study skins and cleaned bones). The standard method of preserving amphibian specimens involves fixing in 10% formalin and storage in alcohol, usually 70% ethanol.

Materials:

To make good amphibian specimens, you will need:

1. **Killing agent**: The best and most humane way to kill frogs is with an overdose of anesthetic. Two of these are tricaine methanesulfonate (tricaine, MS-222) and benzocaine. (At dosages appropriate for non-lethal anesthesia, frogs will experience full recovery from both of these drugs when revived in clean, flowing water.)

   MS-222. Tricaine methanesulfonate is commonly used for painless anesthesia of amphibians and fish. It is available from a number of suppliers (Argent Laboratories, Western Chemical). Complete immersion in a solution of 10 g/L (a 1% solution) or stronger will effectively kill frogs and tadpoles, usually within 30 minutes. (Note that this concentration is much higher than that used for non-lethal anesthesia.) When mixed with water, pure tricaine will make an acidic solution, which prevents most of it from being available as an anesthetic. Because of this, stock solutions should be buffered to a near-neutral pH.

   To make a stock solution, thoroughly mix 10 g of tricaine powder into 1 L of clean water (distilled water, dechlorinated tap water, or clean stream water). With test paper, measure the pH of the resulting solution: if it is less than 6, add sodium bicarbonate 1 g at a time, mixing thoroughly, until the pH of the solution is between 6 and 7.

   Stock solutions of tricaine do not last a long time under field conditions; therefore, if you are using it infrequently, it is best to carry tricaine powder (premeasured, if desired), and a container for mixing a solution in. When using tricaine, wear nitrile gloves, and follow safety directions.

   Benzocaine is also used to provide anesthesia for amphibians. It is easy to get (it is the active ingredient in Orajel) at department and drug stores. The easiest formulation to use is Orajel's "maximum strength toothache liquid". This is a liquid preparation with a 20% benzocaine concentration. There are two ways to use this product:

   1) Dissolve 10 g of Orajel (about a tube) in 20 mL of ($\geq$ 95 %) ethanol, then add to 1 L of clean water and mix thoroughly. The resulting solution (0.2%) will anaesthetize and subsequently kill frogs upon continuous immersion.

2) Alternatively, a few drops of the Orajel liquid or the "maximum strength" gel formulation (also 20% benzocaine) placed on the head of a frog (between and immediately behind the eyes) will overdose and kill it.

One advantage of benzocaine is its ease of use: the Orajel products mentioned here are fairly stable under field conditions and are also easy to carry.

Ethanol. A third potential killing agent is ethanol (ethyl alcohol). Frogs can be anaesthetized via immersion in a 5% solution of ethanol; immersion in a solution of >20% ethanol will kill them. (Ethanol should only be used for anesthetizing frogs that are to be killed, since it can cause irreversible physiological effects, especially at higher concentrations.) Depending on the concentration, ethanol solutions may take longer to kill frogs than the previous two chemicals, but frogs die in a relaxed state that is recommended for preparation as museum specimens. Ethanol solutions are easy to prepare and can be stored for a long time (months) in a well-sealed container which prevents evaporation.

2. **Tissue fixative**: The standard fixing solution is 10% formalin. Formalin can be purchased as a 10% solution, or can be prepared from a full-strength solution. Full-strength formalin is an approximately 37% solution of formaldehyde gas in water. (This solution can be diluted to 10% formalin by mixing 1 part solution with 9 parts distilled water.) Full-strength formalin is toxic; use it in a well-ventilated area, wear nitrile gloves, and avoid breathing it.

   When exposed to air, formalin eventually becomes acidic, and may damage specimens. To prevent this, it should be buffered with either magnesium carbonate or sodium phosphate at the following ratios.

   - Magnesium carbonate: 5 ml/liter of 10% formalin (19 ml/ gallon of 10% formalin).
   - Sodium phosphate: 4.0g of monobasic sodium phosphate plus 6.5g of dibasic (anhydrous) sodium phosphate per liter of 10% formalin.

   Alternatively, you can just buy 10% formalin that is already buffered (neutral) from some suppliers. (For sources of chemicals, see the equipment list at the end of the "Survey Equipment" section.)

3. **Preservative** (storage solution): The best solution for storing frog specimens is 70% ethanol. Egg masses and tadpoles may require a formalin solution or a lower concentration of ethanol for proper storage (see below).

4. **Containers** with tight-fitting lids (trays for preparation and jars for storage): Trays are used for positioning animals while tissues harden. Dissecting pans and plastic food storage dishes (like Gladware) make good trays; the latter have the advantage of tightly-fitting lids.

5. **Tools** (syringe, scalpel, forceps are useful): A syringe (available in a variety of sizes at medical supply and farm stores) is used for injecting specimens with preservative; forceps are used to position specimens in fixing solution and remove specimens from storage jars.

6. **Waterproof labels**: A water- and solvent-proof label should accompany the specimen at every step: a specimen without collection and locality data is worthless. The best label material is 100% rag paper, although Rite-in-the-Rain copier paper is fairly resistant to solvents and will suffice. Labels should be written in non-fading India ink, although in a pinch, #2 pencil (press hard) is a good substitute. The black waterproof ballpoint pens made by Rite-in-the-Rain will also work in a pinch. Although the writing remains legible, the ink will run enough to color a preserving solution. Labels should be placed in the jar with specimens; in the case of frogs, they can be tied to the specimen with cotton thread (see below).

   ALL specimen labels should contain the following: Date, location (include county and state), collector, and species. In addition, a reference number corresponding to an entry in the field notes for that day is highly recommended.

Collecting Eggs

Collection:

Egg masses are very difficult to transfer between containers without ruining them. Therefore, if collection of an intact mass is your goal, it is best to collect it in the container that you want to preserve and store it in. As with frogs and larvae, the best containers for preserving and storing specimens are glass jars with water-tight lids. (Think of the lid on a pickle jar.) Be sure the lids have a rubber seal, not just a paper liner. Pick a large enough jar that the egg mass can float freely in it (i.e., there is liquid on all sides of the mass, between the eggs and the sides of the jar). If the jar is too small, the egg mass will not be preserved properly, and it will also have little value for teaching or reference purposes, since the original shape will be impossible to see. Take the jar with you into the field, and collect the egg mass by gently scooping it into the jar. Hold the jar underwater to put the lid on, so that the jar is completely full of water, with no air space which would allow the egg mass to slosh around and be damaged. Carefully carry the mass back to a place where you can preserve it– for a long trip, keep it as cold as possible without actually freezing it (i.e., packed in a cooler full of ice).

Preservation:

There are two good methods for preserving frog eggs. Both techniques are the same whether the specimen is a whole egg mass, or just a sample of eggs. These methods are as follows:

Method 1: Start with the egg mass in the collection jar. Slowly and carefully, pour out as much water as possible, without deforming or ruining the mass. Write up your waterproof collection label and put it in the jar. The next step is to add

formalin. If the formalin is 10%, carefully fill the jar with as much as possible (up to the brim, if you can), and replace the lid. There will be a small air space in the jar, but that's okay. If you have it, you can use a stronger formalin solution, and just not pour out as much water. The author prefers to use a stronger solution – up to 30%. If you have stronger formalin, you don't have to pour out as much water to achieve an effective concentration.

Once you pour the formalin solution in the jar, you will notice that the egg mass quickly rises to the top (it has positive buoyancy). Seal the jar tightly, and carefully put it in a cold place, like a refrigerator. Ideally, you will keep it below 50^{o}F (40-45^{o}F is good). Preservation will take several weeks, due to the large amount of water in the jelly. Every few days, gently turn the jar to ensure proper coverage of the preservative. After several weeks, you will notice that the egg mass gradually sinks to the bottom of the jar (it has negative buoyancy). This is the sign that preservation is complete. At this point, the mass can be removed from refrigeration, and can be stored in a formalin solution or transferred to ethanol.

In a well-ventilated place, pour off as much of the formalin as possible, and replace with a fresh solution of buffered 10% formalin. For ethanol storage, re-fill the jar with a solution of 30-50% ethanol. Use a stronger solution for large, watery egg masses (*e.g.*, red-legged or spotted frog) and a weaker solution for smaller ones (*e.g.*, Pacific tree frog). 70% ethanol is usually too strong for formalin-fixed egg masses. If your ethanol concentration is too high, you will notice that the egg mass shrinks and takes on a "cottony" appearance. It can be restored to its proper appearance by decreasing the concentration of ethanol.

Method 2: Start with the egg mass in the collection jar. Slowly and carefully, pour out as much water as possible, without deforming or ruining the mass. Write up your waterproof collection label and put it in the jar.

Fill the jar with 90% ethanol, and refrigerate it for several weeks as described above. Initially, the surface of the mass may shrink and look "cottony", but usually returns to normal as equilibrium is reached. If it doesn't, reduce the ethanol concentration after preservation is complete. This method is much easier than formalin preservation and produces a softer specimen. Preserved egg mass specimens should be stored at room temperature or slightly below, and kept out of strong light, which will fade and ruin them.

Collecting Tadpoles

Collection:

Kill tadpoles quickly and humanely with an overdose of anesthetic. Do not drop live tadpoles into a formalin solution; this is cruel and results in contorted, worthless specimens. The best way to humanely kill tadpoles is to collect them in a jar or container of water, carefully pour out as much water as possible, then pour in a concentrated anesthetic solution (such as MS-222 or benzocaine). Remember that it is the final concentration of the solution the tadpoles are in that is important, and that the water in the collecting jar will dilute the anesthetic solution, so plan accordingly.

Preservation:

Frog larvae are the easiest life stage to preserve, but they are delicate and must be handled carefully during preservation to make useful specimens. In addition, a waterproof collection label should accompany the specimens at all times.

1. As soon as tadpoles are dead, remove them from the killing solution and lay them flat in a shallow tray. If tadpoles are very small, a large jar will work, as long as they will lay flat in it. If necessary, a wet paper towel can be placed on the bottom of the container to hold the larvae in place. Make sure that the body and tail are laid out straight and flat, in a natural position, and that the tail fin is spread, not kinked or curled.

2. Carefully pour 10% formalin into the tray. Use just enough to barely cover the tadpoles. Don't let them float around in too much solution and become distorted. If pouring in the solution disturbs the tadpoles, gently put them back in position with forceps.

3. Leave them alone for several hours. It will take a few hours for the tissues to harden to the point where they can be moved without ruining the specimen. Once the specimens are hardened, they can be gently removed from the tray and transferred to a jar to finish preservation. Or, you can just pour more formalin into the tray and leave them there to finish.

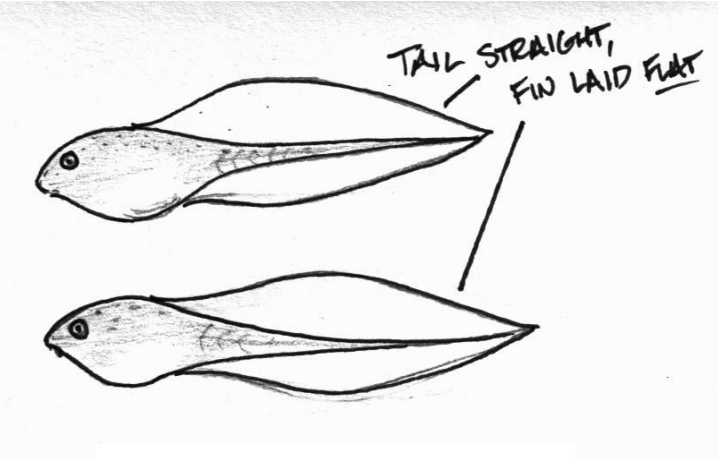
4. The fixing process takes several days. If possible, keep specimens cool during this period (a refrigerator is ideal).

5. After fixing is complete, the specimens may be stored in either formalin or alcohol. To store them in formalin, simply drain off the old formalin and pour in a fresh solution of 10% buffered formalin. For alcohol storage, tadpoles should be removed from the formalin, rinsed quickly in clean water to wash off formalin residue, and transferred to ethanol for storage.

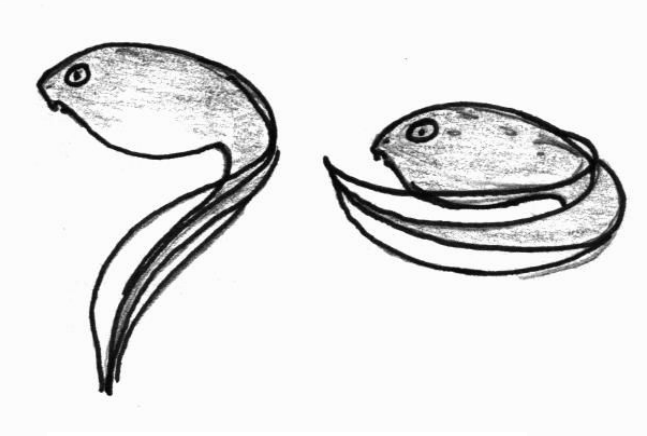
   Because they contain a lot of water, tadpole specimens may have to be stored in ethanol concentrations lower than the 70% recommended for frogs, in order to prevent dehydration. When the specimens are first placed in

ethanol, watch them for a few weeks: if they start to dehydrate (indicated by a wrinkled appearance), reduce the alcohol concentration. It is worth mentioning that different kinds of tadpoles may require different methods of storage. Finding the right storage method may take a little time, but it is worth it: good tadpole specimens are very valuable, but not if they dehydrate.

The best containers in which to store tadpole specimens are glass jars with tight-fitting lids. Preserved tadpole specimens should be stored at room temperature or slightly below, and kept out of strong light, which will fade and ruin them. Except for during transport and use (*e.g.*, study and teaching), specimens should be kept completely covered with ethanol at all times. Do not allow jars to dry out.



Right: Lay tadpoles flat for preservation.



Wrong: Do not leave tadpoles kinked or curled.

Collecting Frogs

Collection:

Kill frogs quickly and humanely with an overdose of anesthetic. Do not drop live frogs into a formalin solution; this is cruel and results in contorted, worthless specimens. The best way to humanely kill frogs is to put them in a jar filled with a concentrated anesthetic solution. Place the frogs in the jar and put it in a sheltered place, like a cooler, or in the shade. Do not leave the jar out in the sun. Using the concentrations recommended above, most frogs will be dead in 30 minutes or less.

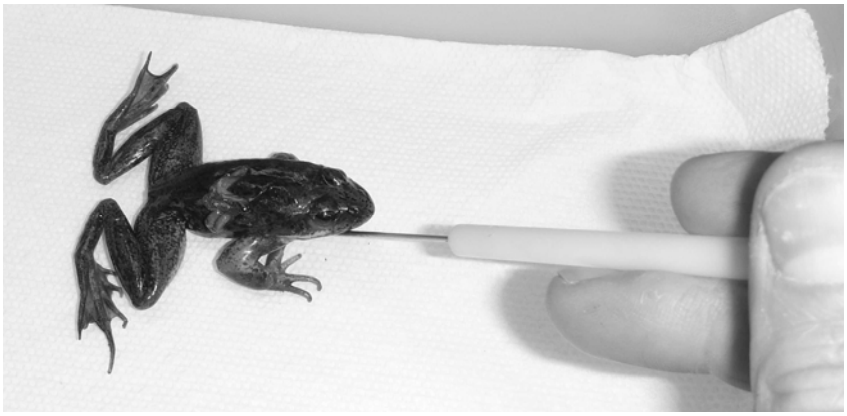
Remember that using anesthetic means that a frog will become relaxed and unconscious prior to death. A frog that is still conscious will be responsive to touch; the last response to disappear is retraction of a limb in response to a touch or toe pinch. To ensure a humane death by overdose, leave the frog in the solution until the cardiac impulse (heartbeat) disappears. In a live frog, the cardiac impulse will be visible through the ventral surface. Rember that the heartbeat will slow dramatically as a result of anesthesia, so look carefully.

Preservation:

Frogs must be preserved properly in order to make to make useful specimens, as contorted specimens have little scientific value. As with tadpoles, a waterproof collection label should accompany the specimens at all times. The best way to preserve frog specimens is as follows:

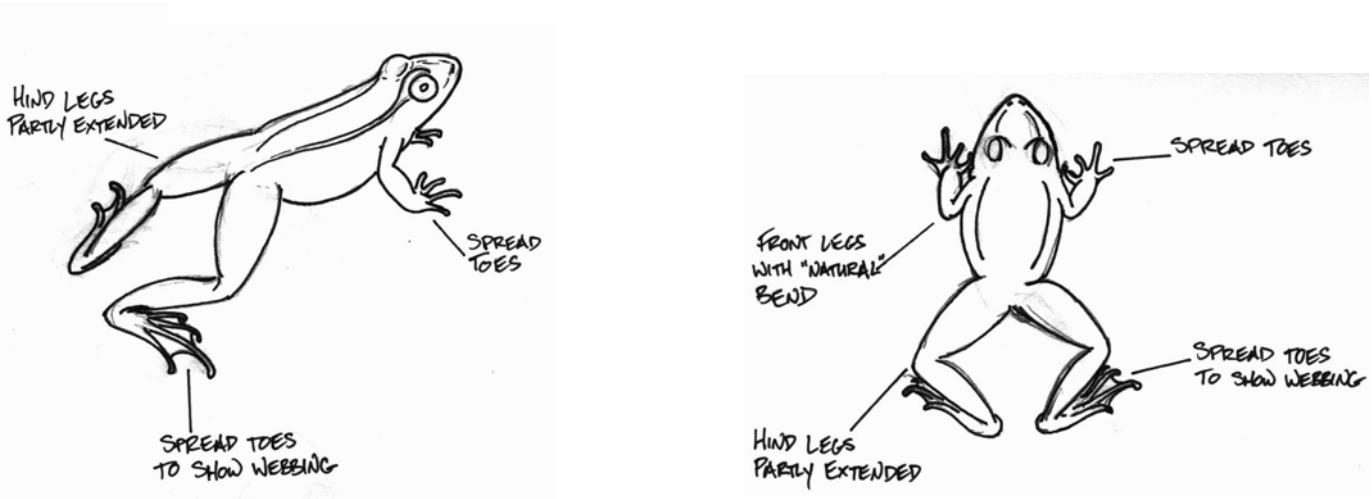
1. As soon as frogs are dead, remove them from the killing solution and position them in a shallow tray. If necessary, a wet paper towel or thin sheet of cork (available at craft or department stores) can be placed on the bottom of the container to hold the larvae in place. Make sure that the frog is positioned properly. The front legs should extend below the body in a normal stance, and the hind legs should be partially extended. The toes of both the front and hind feet should be outstretched, not curled under, and spread apart as much as is possible. If necessary, fine pins (such as insect pins) can be used to pin a frog in position on a sheet of cork.

Wrong: Don't just drop a dead frog into a jar. Contorted specimens have little scientific value.



Right: Lay frogs out with legs partially extended and toes spread. Note use of paper towel, which helps hold the frog in place.

How to position frogs for preservation. Left: side view. Right: Top view.



2. If the frog is large (over about an inch in body length), use a syringe to carefully inject 10% formalin into the body cavity. Don't overdo it; you will give the frog a bloated look. If you do not have a syringe, carefully make a small incision in the side of the frog's abdomen with fine scissors or a sharp knife or scalpel. The preservative must access the internal organs or they will rot, and your specimen will be ruined.

3. Carefully pour 10% formalin into the tray. Use just enough to barely cover the frog. Alternatively, you can cover the frog with a paper towel, and then pour in a small amount of formalin. The towel will absorb the formalin and spread it across the surface of the frog.

4. Leave it alone for several hours. It will take a few hours for the tissues to harden to the point where they can be moved without ruining the specimen. Once the specimen is hardened (fixed), it can be gently removed from the tray and transferred to a jar to finish preservation. Or, you can just pour more formalin into the tray and leave it there to finish.

5. The fixing process takes several days for small frogs, and up to a week or more for very large ones. If possible, keep specimens cool during this period (a refrigerator is ideal). Cooling slows decomposition and you end up with a better specimen.

6. After fixing is complete, the specimen should be removed from the formalin, rinsed in clean water to wash off formalin residue, and transferred to 70% ethanol for storage. The best containers in which to store frog specimens are glass jars with tight-fitting lids. Frog specimens should be individually labeled if possible; tie the label to the frog's hind leg, around the knee.

   Preserved frogs should be stored at room temperature or slightly below, and kept out of strong light, which will fade and ruin them. Except for during transport and use (*e.g.*, study and teaching), specimens should be kept completely covered with ethanol at all times. Do not allow jars to dry out.

Salvaging Dead Stuff

Some of the most valuable specimens you will ever find are animals which have died 'naturally'. These can provide valuable insight into many aspects of a species' biology, including its predators, diseases, behavior, and habitat use. However, if dead frogs are to be preserved for future use, it usually must be done quickly and carefully. In general, preservation methods are the same as for intact specimens of each life stage, though a few additional tips apply:

1. **Collect with care:** Already dead animals, especially frogs, are typically soft and delicate. Pick them up and transport them carefully to avoid destroying them. In particular, use caution not to destroy or lose the skin, as this is an important organ for diagnosing certain amphibian diseases. Rigid containers packed with grass, moss, or paper towel are best for transporting specimens. If a dead frog is found in the water, a good method for salvaging it is to scoop it up in a jar full of water, leaving no air space, as is done for egg masses (see above). Then, keep specimens cool. If possible, transport them back from the field in a cooler full of ice.

2. **Heavy on the sauce:** Use stronger preservative on tissue that has started to decompose. Inject specimens with 10% formalin, then fix in a solution of stronger than 10%, if possible. If you are using alcohol, use the strongest you can get ($\geq$90% is preferable). Inject the body cavity and then immerse the specimen in three to five times its volume of alcohol. After a few days, pour off the diluted alcohol and replace it with fresh. Repeat as needed until the specimen is preserved.

3. **Be cool:** Dead animals have already started to break down. Refrigeration during preservation is essential. If possible, transport specimens back from the field in a cooler full of ice. Also if possible, don't freeze them – frozen amphibians preserve poorly. If you do have to freeze a specimen for whatever reason, don't thaw it before preservation. Just immerse it in $\geq$90% alcohol, as described above. Let it thaw out slowly in the preservative, then inject the body cavity with more alcohol, and refresh the alcohol solution it is in as many times as is needed. Keep it refrigerated until preservation is complete.

4. **You win some…**and you lose some. Sometimes, an animal is just too decomposed to salvage. Take as good a photo as you can, make detailed notes, and let 'er lie.

Frog CSI: Photographing a dead frog in the exact location and position it was discovered often provides valuable clues to the cause of death.

A final note…

Physical specimens have many advantages over photographs. Besides providing irrefutable proof of a species' identity, they are useful in studies of many aspects of amphibian biology, including distribution, occurrence, morphology, systematics, life history, disease, parasitology, growth, age, and reproduction.

However, specimens also have their drawbacks: compared to photos, specimens are much more difficult to make, store, and transport. The color of specimens soon fades and is thus not representative of a living animal. Most importantly, collection of specimens requires removal of living animals from a population, which in some cases is not desirable.

For these reasons, the decision to collect specimens should not be made lightly, but should be thoughtfully and carefully performed in accordance with the needs of management or research. Done properly, appropriately collected specimens add great scientific value to a program of amphibian monitoring and study.

Additional Reading

Amphibian anesthesia and euthanasia:

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4g. Disinfection

Disinfection of equipment to prevent the spread of disease has become an important part of wildlife management and research. Amphibians have their own set of bacterial, fungal, and viral pathogens, and it is really up to the individual surveyor whether they become a vector of these diseases or not.

When

Waders, boots, nets, and clothing:

1. When moving between sites
2. Weekly, during use at the same site

During inventory surveys, this stuff should be disinfected in between each hydrologically separate site. More specifically, when you move equipment between sites that are not connected by water, the potential for transmitting disease exists. In reality, many refuges are a single hydrologic unit, so equipment can just be assigned to a particular refuge. It is still a good idea to sterilize it periodically, however. For large or complex refuges, or when moving between refuges, equipment should be sterilized.

Containers:

1. Between sites
2. Daily, at the same site

Sterilize containers between sites, or every day that they are used to hold animals, whichever is more frequent. For example, if you use some jars for frogs at the same spot on the same refuge all day, then wash them at the end of the day. If you use them at one refuge in the morning and then head to another in the afternoon, wash them before you go to the second site. This one is important, since "catch-and-release" containers really have potential to spread disease if you are not careful. Be sure to wash containers.

Ziploc bags are cheap, and can be thrown away (or recycled) after measuring frogs. Do not move them between sites. Do not reuse them. Throw them away.

Other stuff:

This is the equipment nobody really thinks about: rulers, clips on spring scales, *etc*. It should be sterilized as often as containers.

How

Waders, boots, nets, and clothing:

Spray waders, boots, and nets with a solution of 5-10% chlorine bleach or 90% alcohol (either ethanol or isopropanol). Be sure to get the surfaces covered thoroughly, including the tread on boots, and the insides of wading boots. If you don't disinfect the entire article, there is really not much point to treating any of it. A spray bottle with pre-mixed bleach solution or 90% alcohol really comes in handy here.

Alcohol will simply evaporate, but if you use bleach, let the waders or boots sit for 10 minutes, and then rinse them thoroughly with water. Otherwise, the bleach will quickly destroy your waders (especially neoprene). With respect to bleach, 5% is about the minimum concentration required to reliably kill amphibian pathogens; 10% is excellent for sterilization purposes, but really hard on equipment.

Clothing can simply be washed. Normal washing machine detergent and settings should do the trick.

Containers:

Jars, buckets, tubs, and other containers that hold live amphibians can be cleaned with alcohol, a 5-10% bleach solution, or simply washed out with a mild dish soap and hot water (Dawn, Palmolive, Joy, Planet, etc.). The most important thing when washing containers is to **rinse them thoroughly** with clean water, so that no residue of soap or bleach is left inside. Throw your used Ziploc bags away.

Other stuff:

The rulers, scale clips, and other small items are just as important as containers, because they also come in contact with live amphibians on a regular basis. They should be cleaned just as frequently. The best disinfectant to use on these is alcohol, because it evaporates, and then you don't have to worry about residue on the equipment coming in contact with living amphibians.

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Appendix 1: Introduction to survey protocols and frequently asked questions

Purpose

The following sections contain protocols for conducting frog inventory surveys on National Wildlife Refuges in the East-side Zone of Region 1.

Why inventory?

Collecting inventory (species occurrence) data is an essential first step for almost every other program of research.

What about monitoring?

Inventory and monitoring are two separate processes. Monitoring refers to the repeated observation of a system in order to detect change. It requires collecting data at multiple points in time. Specifically, data collected at one point are compared to data collected at an earlier point, in order to identify potential trends. Therefore, it is impossible to make any statement about an amphibian population now, if equivalent data have not been collected in the past.

Inventory and monitoring are thus complimentary, and related in a linear manner: Inventory data must be obtained before any monitoring can be performed. An accurate inventory provides baseline information to which future data may be compared.
For example, if you wish to begin monitoring the size of a spotted frog population on your refuge, you first have to know if frogs occur on the refuge, and where they are – basic inventory data. Generally, the more detailed the baseline data are, the greater the inference that can be drawn from comparison to them.

Description

This protocol teaches users how to survey for frogs and toads, using standard visual inventory techniques conducted during daylight hours.

Why visual surveys?

Visual surveys are the best method for collecting inventory data, because:
They are the easiest type of survey to prepare for and perform.
They can be conducted across the widest range of habitats.
They require the least amount of specialized equipment.
They detect a wide range of species and life stages.

Why daylight hours?

Although many species of frogs and toads are nocturnal, many biologists are not. The constraints of the Federal employment system necessitate an effective method for finding target species during the day. Hence, this protocol. (Instructions for nighttime surveys are also included, for those so inclined.)

What about call surveys?

Most of the frog species within the zone covered here do not call loudly enough, or for long enough periods of time, for call surveys to be an effective means of detecting them. This is especially true if using automated recording equipment, or over large areas.

What about trapping?

Trapping, including pit trapping and funnel trapping, can be an effective method of catching frogs, if used properly. However, it is generally not a technique suited to inventory surveys, as it:

- typically requires a much greater amount of time and effort than visual surveys,
- covers less habitat at a time than visual surveys, and
- usually requires some detailed knowledge of frogs and habitat to be successful, as well as to avoid killing target animals.

For these reasons, trapping is not really a method suited to the beginning surveyor, or to basic inventory surveys in general. Therefore, while it is referenced in this document, it is not described in detail. (See the Additional Reading and Reference sections of the Instruction Manual for more information on this technique.)

Appendix 2: Occurrence and detectability of East-side Zone frog species

The following tables list the species of frogs potentially present on East-side zone refuges, along with the relative ease of detection of each life stage, and the time of year a life stage is most likely to be present.

Table 2a. Frog species potentially present on East-side Zone National Wildlife Refuges.

Refuge	Great Basin spadefoot	Western toad	Woodhouse's toad	Boreal chorus frog	Pacific treefrog	Northern red-legged frog	American bullfrog	Columbia spotted frog	Northern leopard frog	Oregon spotted frog	Wood frog
	Spea intermontana	*Bufo boreas*	*Bufo woodhousii*	*Pseudacris maculata*	*Hyla regilla*	*Rana aurora*	*Rana catesbeiana*	*Rana luteiventris*	*Rana pipiens*	*Rana pretiosa*	*Rana sylvatica*
Conboy Lake		P			P	P	P			P	
Toppenish	P		P		P		P				
Hanford Reach	P		P		P		P				
Columbia	P		P		P		P		P		
Umatilla	P		P		P		P		P		
McNary	P		P		P		P		P		
Cold Springs	P	P			P						
McKay Creek	P	P			P						
Turnbull	P	P			P			P			
Little Pend Oreille	P	P			P		P	P	P		P
Kootenai		P			P		P	P	P		P
Deer Flat		P	P		P		P		P		
Malheur	P	P			P		P	P			
Hart Mountain	P	P			P			P			
Sheldon		P			P		P	P			
Camas	P	P		P					P		
Gray's Lake		P		P			P		P		
Minidoka		P		P			P		P		
Oxford Slough		P		P							
Bear Lake		P		P					P		

P = potentially present, based on: 1) detection during 2012 inventory surveys, 2) catalogued museum specimens, or 3) information provided by the USFWS.

Table 2b. Relative detectability of frog species on East-side Zone National Wildlife Refuges.

Species		Detectability of life stages			Notes
Common Name	**Scientific Name**	**Eggs**	**Larvae (tadpoles)**	**Frogs**	
Great Basin spadefoot	*Spea intermontana*	April-June; poor	April-June; poor	April-July; best*	*Road-hunting or night-time call surveys are most effective
Western toad	*Bufo* (*Anaxyrus*) *boreas*	April-July; poor	May-August; good to best	May-September; good to best	Tadpoles jet black, form large schools, are easy to see; juveniles abundant, easily found during transformation
Woodhouse's toad	*Bufo* (*Anaxyrus*) *woodhousii*	April-July; poor	April-July; poor	May-September; best*	*Road-hunting or night-time call surveys are most effective
Boreal chorus frog	*Pseudacris maculata*	April-June; poor	April-June; fair	April-September; best	Most easily found during breeding season (April-May): listen for loud calls
Pacific treefrog	*Hyla* (*Pseudacris*) *regilla*	February-May; fair	April-July; good	February-October; fair*	*Most easily found during breeding season (February-June): listen for loud calls
Northern red-legged frog	*Rana aurora*	January-March; good	April-July; poor	January-November; poor	Egg masses large, stationary, last for a month
American bullfrog	*Rana catesbeiana* (*Lithobates catesbeianus*)	April-August; poor	April-September; good	April-September; best	Juveniles "squeak" when disturbed
Columbia spotted frog	*Rana luteiventris*	April; fair*	May-July; poor	April-September; best	*Egg masses large, easy to see, but often in small area
Oregon spotted frog	*Rana pretiosa*	March-April; fair	May-July; poor	April-September; best	*Egg masses large, easy to see, but often in small area
Northern leopard frog	*Rana* (*Lithobates*) *pipiens*	April-May; poor	May-July; poor	April-September; best	Look for juveniles during summer, adults during breeding season. Often easily found at night.
Wood frog	*Rana sylvatica*	April-May; fair*	May-June; fair	April-August; poor	*Egg masses easy to see, but short-lived, often in small area

Comments: Detectability of life stages rated (as poor, fair, or good) based on the relative ease with which a life stage can ***consistently*** be found during standard visual surveys; "best" rating indicates the best life stage to use for inventory purposes, not that it is necessarily 'easy' to find.

Appendix 3: General Frog Survey Protocol

Instructions for conducting a general inventory survey for frogs . For detailed instructions on sampling methods, survey techniques, equipment sources and selection, *etc*., please refer to the accompanying instruction manual.

Equipment

Required

- Waders
- Wading boots
- Dip net
- Data sheet or notebook
- Pencils or waterproof pens
- Camera
- Plastic ruler
- Digital thermometer
- Ziploc bags
- Small jar or clear container
- Drinking water
- GPS

Optional

- Backpack
- Compass
- First aid kit
- Flagging tape
- Hat
- Map
- Measuring tape
- Pocket knife
- Sharpie marker
- Spring scales
- Duct tape
- Specimen jars
- Food
- Field guide
- Collecting supplies
- Flashlight or headlamp
- Fire starters
- Space blanket
- Extra water
- Photography containers
- Garbage bag
- Cloth bag

Preparation

Planning your survey

Conduct your frog surveys from mid-April or May through early September.
Conduct egg surveys from March through May for most species.
Conduct tadpole surveys from early May through June for most species.

Check the weather forecast, and try to pick survey days that are:

1. at least partly sunny,
2. with little or no wind
3. warm (for frog surveys); daytime high temperature between 65 and 85 ^{o}F, for best results

Scouting the site

If possible, scout the survey site beforehand, to determine its location and get an idea of the amount and type of habitat present. For surveys conducted during the spring breeding season, a good method is to drive by the site and listen for any frogs calling. This works best at night.

Look for good habitat, as well as obstacles like deep water, steep banks, and fences. Also look for the easiest way to get in and out of your survey site (long walks are less fun in waders).

Before you survey
Before you leave, assemble your equipment and check to make sure everything is ready, so you don't waste valuable field time. Make sure your camera batteries are charged, and that you have enough drinking water.

Survey instructions

Starting the survey

At the start of a survey, record the following information for each site:

1. **Location**. Include both a description with site, refuge, county, and state, and UTM coordinates of your start point.
2. **Date**. Write out the month name.
3. **Surveyors** present. Write out first and last names.
4. **Time** survey was started. Use 24-hour format.

How to search

For frogs

Conduct your survey by walking **slowly** and **quietly** along the shoreline of a survey site, watching the bank and the water's surface ahead of you. Frogs often sit in shallow water, frequently among weeds. They will also hide in grass and weeds along the bank. Check patches of grass and reeds by gently swishing them with a net handle and watching for to frogs jump out. When aquatic weeds form mats over the water's surface, check them with binoculars before you get close. Binoculars are also useful for searching the edges of ponds that have no cover, as well as for frogs that are wary and flee at your approach.

When you survey, move as quietly as possible. Don't talk loudly, stomp around, or splash. The more disturbance you make, the fewer frogs you will see. Go slowly and check the area as thoroughly as possible.

For tadpoles

Over the survey area covered here, early May through June is the best time to find tadpoles. Look for them by walking or wading around the edges of a survey site. A good starting place is shallow water with lots of weeds, as well as anywhere you have heard frogs calling. You can often see tadpoles swim away from you if you wade slowly. Use a dip net to catch them. Sweep a dip net rapidly through submerged weeds to catch tadpoles that are hiding.

For eggs

Over the survey area covered here, March through May is the best time to find frog eggs. Look in water ranging from about four inches to two feet deep. Good places to start are shallow edges with abundant grass or weeds and south-facing shorelines. Other good places include spots where ponds are bordered by marshes or stands of thick brush or woods. If you scouted the site, anywhere you heard frogs calling is an excellent place to check.

Wade slowly and try not to splash or ripple the water, since it makes it hard to see below the surface. Survey during periods of good light. Avoid stormy, overcast, or windy weather. Polarized lenses will help you see beneath the surface. Eggs may be attached to plants, sticks, or just left on the bottom in very shallow water. When you find eggs in one spot, look carefully; there will usually be more nearby.

When you find frogs

Attempt to catch and photograph the first frog of each species detected during a survey. Collect a voucher photograph of each species from each site surveyed.

For each survey site and species, record the following information:

1. **Species.** Use both the common and scientific names, if you know them. If you aren't sure what species you have, don't guess. Write a description of the frog.
2. **Photograph.** Take a picture of the frog as proof you found it and to identify the species, if you aren't sure. For the first frog of each species at a site, always take a photograph, even if you can identify it. (For instructions on taking voucher photographs, see section 4d, "Photography", of the instruction manual.)
3. **Life stage.** Egg, larva (tadpole) or frog
4. **Number.** Record how many frogs you found
5. **Location.** Record the frog's location. Use UTM coordinates and a short written description
6. **Habitat.** Take a photograph of the habitat and write a short description
7. **Time found.** Note the time the frog was found
8. **Notes.** Anything else of interest or importance. For example: was the frog calling? Did you measure it?

Need help with identification? See the instruction manual!

Section 4 has tips on identification and a list of useful field guides for the project zone.

Appendix 2 lists the frog species which occur in the project zone.

At a survey site, if you find more frogs of a species you have already recorded and photographed, you don't need to catch or photograph them. Instead, record the information above. Record new coordinates if frogs are in a different habitat or location than the first ones you saw. If frogs are in a different type of habitat, take a photo of it.

If you find eggs: Record the same information as for frogs, along with a written description of the eggs' size and shape. Include the eggs' location, the depth of water you found them in, and whether they are attached to something, like a stick or plant stem.

This information will help identify them. Take photographs of a) the eggs, if possible, and b) of the habitat where you found them.

See section 4 of the instruction manual for directions on how to identify and photograph frog eggs.

If you find tadpoles: DO NOT HOLD THEM IN YOUR HAND!! Remember to use a jar for examining tadpoles. Record the same information as for frogs, along with a written description of the tadpoles. If possible, photograph or collect one for identification.

See section 4 of the instruction manual for directions on how to identify and photograph tadpoles.

Ending the survey

When you stop surveying a site, record the following information:

1. **Time** survey was ended. Use 24-hour format.
2. **Weather** conditions over the survey interval. Describe the average weather conditions.
3. **Typical habitat**.
    a. Write a short description of the average habitat present at the site.
    b. Take a photograph that shows a sample of this habitat type.

After the survey

When you finish for the day, do the following:

1. **Photocopy** your notes and/or enter your data into a database.
2. **Download** your camera and label the photos. One method that makes organization easy is to label each photo with the survey site name, survey date, and a photo number. Camera download software can be set to do this automatically.
3. **Disinfect** your equipment.

Appendix 4: Oregon spotted frog, *Rana pretiosa*

Introduction

A highly aquatic frog that favors marshes and still water with abundant vegetation. It generally occurs west of the Cascade Mountains, except for a few areas in central Oregon. Within the survey area, it is known to occur only at Conboy Lake NWR.

Oregon spotted frog, *Rana pretiosa*. Klickitat Co., Washington.

Description

A stout frog with relatively short legs, heavily webbed hind feet, and eyes that are turned upward.

Adult frogs are usually brown or reddish-brown, with dark spots that look irregular and splotchy. Ventrally, they are white (or white with gray mottling), with red color on their legs and belly. The red color appears to be on the surface of the skin, as if it were painted on.

Juvenile and recently metamorphosed frogs are lighter brown and have smaller spots; they have a white venter with little or no red pigment. The amount of red color increases with age.

Juvenile bull frogs (*Rana catesbeiana*) are often confused for spotted frogs, but bull frogs have longer legs, lack upturned eyes and usually have a bright green snout and very small black spots (fine speckling) over their dorsal surface. Stebbins (2003) and Corkran and Thoms (1996) are good identification guides for this species (but note that Corkran and Thoms do not distinguish this species from *Rana luteiventris*, so location will have to be taken into account).

The amount of pigment on a spotted frog's belly increases with age. Left to right: Juvenile, adult, and large adult Oregon spotted frogs.

Site selection

Without locality data, the best way to select survey areas is to look for suitable habitat. Oregon spotted frogs are highly aquatic, so a survey site must contain at least some permanent water, which should also be slow moving – a pond, lake, ditch, deep marsh, or slow stream. The frogs use the permanent water for overwintering and for surviving dry periods of late summer.

The best habitat for this species will consist of seasonal marshes or flooded overflow areas adjacent to permanent water, or permanent lakes with wide, shallow margins. Look for sites with abundant emergent or floating aquatic vegetation, in the form of rushes, stands of sedges, weed mats, etc. These frogs prefer densely vegetated habitats and will rarely be found away from thick plant growth.

Timing

At Conboy Lake NWR (1800' elevation), *Rana pretiosa* begins breeding in late February or early March, and most breeding is complete by mid-March, though egg masses can be found until April. Elsewhere, this species breeds from mid-February (Puget Trough and Willamette Valley floor, < 200' elevation) to April (at higher elevations in the Oregon Cascades). The growth rate of tadpoles is dependent on water temperature, but transformation occurs in 70-100 days at many sites. The larger larvae are most detectable, so the best time to find tadpoles is for a 1-2 month period, starting about a month after they were laid as eggs.

Adult frogs are difficult to find during overwintering and breeding, but become much more visible several weeks after spawning concludes (May-June), and are easy to find during the summer months, until about the beginning of September, when the weather starts to cool and the frogs become less consistently visible. Juveniles are most visible in late spring and summer; look for recently transformed frogs (metamorphs) from June through August.

The best survey times are generally:

Eggs = March (February at low elevations and April at high elevations)
Tadpoles = May-June
Frogs = May-August

One last consideration when planning surveys are the combined hydrology and vegetative characteristics of a particular site. Frogs are generally most active, most abundant (due to the presence of recently transformed juveniles), and most concentrated during mid- to late summer. However, if the site has dense stands of vegetation that make summer surveys difficult, then spring surveys, performed before the plants get tall, might be more productive.

Survey Methods

Eggs

The best place to look for eggs of this species is at the shallow margins of a water body in which frogs have already been found. This may be simply the edge of the same pond where frogs spend the rest of the year, or it may be in flooded marshland ¼ mile or more from the frogs' summer or winter locations. The distance frogs travel to breed will depend on the arrangement of the habitat in a particular area. In general, the best place to begin searching is the shallowest margin that is present during breeding season. For example, if late winter flooding causes a lake to overflow 200 m into an adjacent marsh, start searching at the upper (shallowest) margin of that marsh, and work your way back toward the lake. Searching shallow margins may be difficult in large freshwater marshes or flooded fields, which might cover many miles and be fairly uniform in composition. In these cases, there are a few tricks you can use to help narrow your survey area:

First, consider timing. When do these areas have water? Eliminate those that hold water at the wrong time or for too short a period (*e.g.*, that flood for just a few weeks) to support breeding. Second, consider when they fill. Do some habitats fill earlier and thus allow frogs more time to get into them? Is this pattern consistent between years (= more likely to support frogs) or irregular (less likely to support frogs)?

Second, consider location. Start with habitats that are closest to known (or suspected) overwintering areas. Although spotted frogs can move long distances to lay their eggs, they won't if they don't have to.

Third, look for key features. Spotted frogs prefer to travel in water, so look for potential breeding sites that have an aquatic connection to an overwintering area. Good features include: a permanent pond near (or flooded into) a marsh, a deep ditch or stream channel running through a site, or a nearby spring.

As you narrow your search further, consider the effects of cover. Spotted frogs tend to avoid dense forest when possible, so move your search away from close trees and into more open areas. Within a marsh, frogs prefer breeding in areas of low emergent growth to dense tall strands of cattail, bulrush, or bushes (like *Spiraea*). At an egg-laying site, look for short vegetation and shallow water. Avoid stands of upright cattails, bulrushes, or canary grass, and search in open areas, or look for pockets where tall grass or weeds have laid down.

This is where it pays to be thorough: spotted frogs often lay eggs communally, so the egg masses of an entire population may be piled together at one spot.

Oregon spotted frog breeding habitat. Klickitat Co., Washington.

Identification: Oregon spotted frog egg masses are grapefruit or softball-sized, and usually found in very shallow water (1.5 feet deep or less). Eggs are simply left on the bottom, often in pairs or piled together, and not attached to sticks or plants.

Within the range of the Oregon spotted frog, egg masses may be confused with those of Cascades frogs and Northern red-legged frogs. (Red-legged frogs do occur in very limited numbers at Conboy Lake NWR.)

When trying to distinguish between egg masses of these species, use geography, location, and general appearance of the mass. Finally, when you do find eggs, mark the location – frogs often lay eggs in the same place in successive years.

Survey conditions: Egg mass surveys should be conducted during the best light period (0900-1600 hours) of a still, sunny (or partly sunny) day with as little precipitation and wind as possible. Rain and wind disturb the water's surface and make it very difficult to see the clear egg masses, even in shallow water.

Tadpoles

Newly hatched Oregon spotted frog tadpoles.

Spotted frog tadpoles are usually more difficult for new surveyors to find than are egg masses. This is because tadpoles blend in with their environment and hide in dense vegetation when disturbed. The best place to search for tadpoles is in a location where breeding was observed. Tadpoles will usually remain close to the place eggs were laid for about a month after hatching, or as water conditions permit. As tadpoles age, they often move towards areas of denser vegetation, and sometimes, deeper water.

If the location of breeding is not known, wait a few weeks after the time breeding was suspected to begin your survey. Larger tadpoles are easier to see and harder step on (they swim faster) than small, newly-hatched ones.

To find tadpoles, begin your search in the margins of a site. Look along shallow, heavily vegetated edges of ponds, streams, or slow ditches. If possible, approach sites on land, walking slowly and quietly, and examine the shoreline – tadpoles will often gather in shallow water to feed and warm up, especially as they get older. If no tadpoles are seen (or in larger marshes where bank searching is not possible), wade slowly through the water, watching ahead of you for tadpoles. Wading often scares tadpoles out of hiding and they are easily seen when they flee through open water. Using a dip net, scoop through shallow patches of submerged vegetation. Preferred types includes strands of ruches (*Juncus*, *Eleocharis*) and patches of pondweed (*Potamogeton*).

***Identification*:** Spotted frog tadpoles are fairly easy to identify. They grow to several inches in length before transformation, and are typically some shade of brownish or olive-green dorsally, with small darker spots in the center of their back. These spots get more distinct as the tadpoles age, but never appear as "sharp" or clear as those of a bullfrog tadpole. The belly of a spotted frog tadpole is usually some shade of silvery or

dirty white, which blends gradually into the color of the sides. The top of the tail fin begins on the back of the tadpole, not at the base of the tail, and if the tadpole is viewed from above, the eyes do not extend beyond the body outline.

Survey conditions: The best time to conduct tadpole surveys is during the highest light period (0900-1700 hours) of a still, warm (65-85°F) day that is at least partly sunny. Under these conditions, tadpoles are usually easiest to find during late morning and late afternoon. Overcast skies and precipitation make it difficult to see into the water.

Frogs

Frogs are usually the easiest *Rana pretiosa* life stage to find, since they are present over the longest time period and are often active during daytime surveys.

Survey conditions for highest detectability should be: still air or light breeze, sunny or partially sunny conditions and warm temperatures (air temperature = 70-85°F). The best times to survey are between 0900 and 1700 hours daily, during the period of May – August. (The daily period of highest visibility will depend on temperature and water conditions, but will fall within this interval.)

Spotted frogs are highly aquatic, and are almost never found far from water, under the survey conditions described. Surveys for spotted frogs should focus on the bank and near-shore areas of quiet water. As with tadpoles, a quiet approach from land will scare the fewest frogs and increase your success rate. Along the bank, it is usually best to look in the water first, as this is where most frogs will be seen at any given time. Favorite places of Oregon spotted frogs are: in shallow water among patches of rushes, atop grass or sedges that are flattened down in shallow water or are shallowly covered with water, and in mats of floating aquatic vegetation or algae. Typically, smaller frogs will sit entirely on top of floating weeds or flattened, submerged grass, while larger frogs will submerge themselves in such cover, with only their eyes and nose above water.

In these situations, the brown-and-black coloration of the spotted frog allows it to conceal itself quite well, and you will have to look very carefully to see them. Spotted frogs are generally sluggish and rely primarily on their coloration to avoid capture. They are easy frogs to catch, if you approach slowly and carefully (see "Capture and Handling" in the instruction manual). In deep water or a vegetation mat that is not too thick, they are best taken with a net. When scared or missed, they will duck beneath the water and swim down – but if the fright is not too severe, they will often reappear nearby after a little while. These are very slippery frogs, especially the adults, but are poor jumpers and thus easily confined in a net. Juveniles are usually found in shallow water and are best caught by hand. Except during periods of cold weather, this species rarely uses cover objects unless they are as least partly submerged (e.g., a log laying out into the water). Turning rocks and logs on land is usually of little value.

Top: Preferred habitat of Oregon spotted frogs: still water with extensive weed growth.

Bottom: Oregon spotted frog in typical habitat.

Field survey protocol for the **Oregon spotted frog, *Rana pretiosa***

Equipment

Required

- Waders
- Wading boots
- Dip net
- Data sheet or notebook
- Pencils or waterproof pens
- Camera
- Plastic ruler
- Digital thermometer
- Ziploc bags
- Small jar or clear container
- Drinking water
- GPS

Optional

- Backpack
- Compass
- First aid kit
- Flagging tape
- Hat
- Map
- Measuring tape
- Pocket knife
- Sharpie marker
- Spring scales
- Duct tape
- Specimen jars
- Food
- Field guide
- Collecting supplies
- Flashlight or headlamp
- Fire starters
- Space blanket
- Extra water
- Photography containers
- Garbage bag
- Cloth bag

Preparation

Planning your survey

Conduct surveys at the following times. Remember that frogs generally breed earlier at lower elevations.

Frog surveys: May through early September.
Egg mass (breeding) surveys: late February through April.
Tadpole surveys: early May through June.

Check the weather forecast, and try to pick survey days that are:

1. at least partly sunny,
2. with little or no wind
3. for frog surveys, pick warmer days (daytime high temperature of 65 to 85 ^{o}F), for best results

Scouting the site

If possible, scout the survey site beforehand, to determine its location and get an idea of the amount and type of habitat present.

Look for good habitat (see species account), as well as obstacles like deep water, steep banks, and fences. Also look for the easiest way to get in and out of your survey site (long walks are less fun in waders).

Before you survey

Before you leave, assemble your equipment and check to make sure everything is ready, so you don't waste valuable field time. Make sure your camera batteries are charged, and that you have enough drinking water.

Survey instructions

Starting the survey

At the start of a survey, record the following information for each site:

1. **Location**. Include both a description with site, refuge, county, and state, and UTM coordinates of your start point.
2. **Date**. Write out the month name.
3. **Surveyors** present. Write out first and last names.
4. **Time** survey was started. Use 24-hour format.

How to search

For frogs

Conduct your survey by walking **slowly** and **quietly** along the shoreline of a survey site, watching the water's edge and surface for frogs. If you have scouted the area beforehand, try to time your survey so that you are in the best habitat between late morning and noon, which is often a good period to see spotted frogs. In cooler weather, frogs are most visible during the warmest part of the day, usually early afternoon.

Spotted frogs are very aquatic and will be in water most of the time. They often sit in shallow water, usually among weeds. They also hide in patches of grass and weeds along the bank. Check these patches carefully. If they are too thick to see into, rustle them with a net handle and watch for to frogs jump out. This species is most likely to sit on the bank during early morning, after dark, and when small juveniles are present (late summer). When aquatic weeds form mats over the water's surface, check them with binoculars before you get close. Binoculars are also useful for searching the edges of ponds that have no cover.

When you survey, move as quietly as possible. Don't talk loudly, stomp around, or splash. The more disturbance you make, the fewer frogs you will see. Go slowly and check the area as thoroughly as possible. If you scare a frog into the water, wait quietly for a few minutes, or return to the spot after a half-hour or so. Spotted frogs will often re-surface in the same place they dove in.

For tadpoles

Over the survey area covered here, early May through June is the best time to find tadpoles. Look for them by walking or wading slowly around the edges of a survey site. The best habitat is shallow water (less than two feet deep) which is not shaded and has open areas mixed with patches of grass or weeds.

As you move, watch the water ahead of you for tadpoles fleeing your approach. Periodically check submerged weeds or grass for tadpoles by dip netting. Sweep a dip net rapidly through the weeds or grass several times – tadpoles often escape the first time but are caught in subsequent tries.

For eggs

For Oregon spotted frogs, March through April is the best time to find eggs. Look in very shallow water: spotted frogs usually lay their eggs in water less than a foot deep. The best places to start searching are open, sunny edges of ponds and marshes, especially if they have short grass or weeds.

Wade slowly and try not to splash or ripple the water, since that makes it hard to see below the surface. Survey during periods of good light. Avoid stormy, overcast, or windy weather. Polarized lenses will help you see beneath the surface. Spotted frog eggs are usually just left on the bottom in very shallow water. Often, many egg masses are laid together in a single pile. When you find eggs in one spot, look carefully; there will often be more nearby.

When you find frogs

Attempt to catch and photograph the first frog of each species detected during a survey. Collect a voucher photograph of each species from each site surveyed.

For each survey site and species, record the following information:

1. **Species.** Use both the common and scientific names, if you know them. If you aren't sure what species you have, don't guess. Write a description of the frog.
2. **Photograph.** Take a picture of the frog as proof you found it and to identify the species, if you aren't sure. For the first frog of each species at a site, always take a photograph, even if you can identify it. (For instructions on taking voucher photographs, see section 4d, "Photography", of the instruction manual.)
3. **Life stage.** Egg, larva (tadpole) or frog
4. **Number.** Record how many frogs you found
5. **Location.** Record the frog's location. Use UTM coordinates and a short written description
6. **Habitat.** Take a photograph of the habitat and write a short description
7. **Time found.** Note the time the frog was found
8. **Notes.** Anything else of interest or importance. For example: was the frog calling? Did you measure it?

Need help with identification? See the instruction manual!

Section 4 has tips on identification and a list of useful field guides for the project zone.

Appendix 2 lists the frog species which occur in the project zone.

At a survey site, if you find more frogs of a species you have already recorded and photographed, you don't need to catch or photograph them. Instead, record the information above. Record new coordinates if frogs are in a different habitat or location than the first ones you saw. If frogs are in a different type of habitat, take a photo of it.

If you find eggs: Record the same information as for frogs, along with a written description of the eggs' size and shape. Include the eggs' location, the depth of water you found them in, and whether they are attached to something, like a stick or plant stem.

This information will help identify them. Take photographs of a) the eggs, if possible, and b) of the habitat where you found them.

See section 4 of the instruction manual for directions on how to identify and photograph frog eggs.

If you find tadpoles: DO NOT HOLD THEM IN YOUR HAND!! Remember to use a jar for examining tadpoles. Record the same information as for frogs, along with a written description of the tadpoles. If possible, photograph or collect one for identification.

See section 4 of the instruction manual for directions on how to identify and photograph tadpoles.

Ending the survey

When you stop surveying a site, record the following information:

1. **Time** survey was ended. Use 24-hour format.
2. **Weather** conditions over the survey interval. Describe the average weather conditions.
3. **Typical habitat**.
    a. Write a short description of the average habitat present at the site.
    b. Take a photograph that shows a sample of this habitat type.

After the survey

When you finish for the day, do the following:

1. **Photocopy** your notes and/or enter your data into a database.
2. **Download** your camera and label the photos. One method that makes organization easy is to label each photo with the survey site name, survey date, and a photo number. Camera download software can be set to do this automatically.
3. **Disinfect** your equipment.

Appendix 5: Columbia spotted frog, *Rana luteiventris*

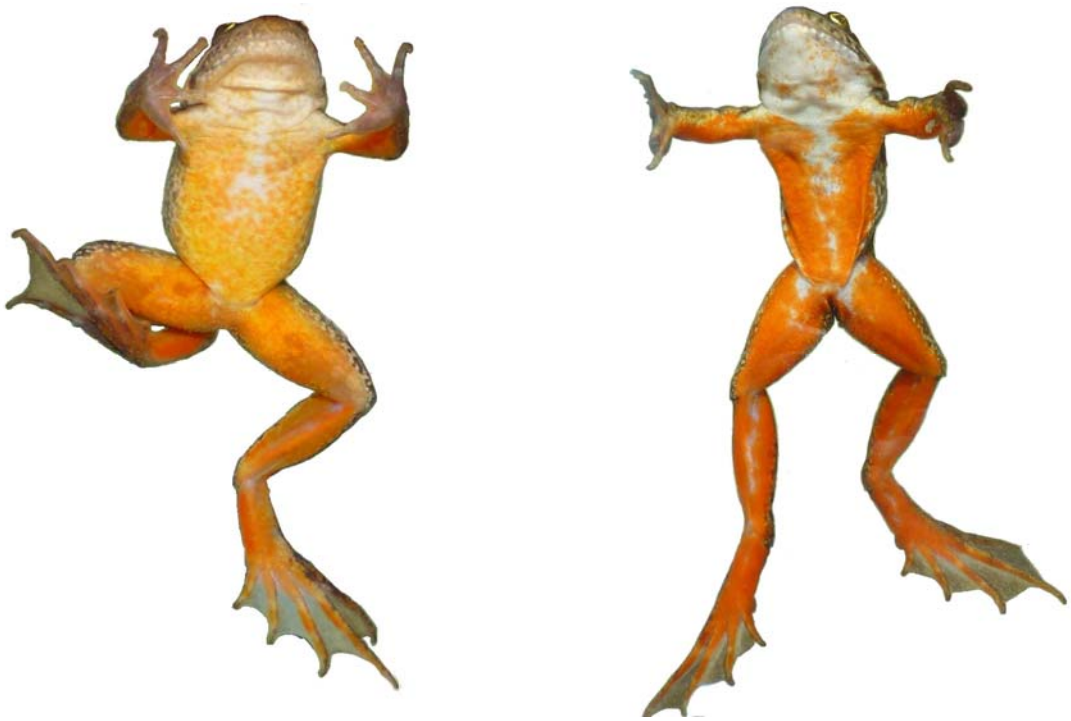
Introduction

A highly aquatic frog which inhabits a variety of slow moving, vegetated waters, including ponds, ditches, springs, and mountain lakes. A frog of the arid west, it is found across the Great Basin and western Rocky Mountain regions at a range of elevations, up to over 9,000 ft. The life history of this frog varies by habitat type and elevation.

Columbia spotted frog, *Rana luteiventris*. Stevens Co., Washington.

Description

A stout frog with short legs, heavily webbed hind feet, and eyes that are turned upward. Columbia spotted frogs are usually some shade of tan or brown dorsally, with irregular dark spots in the center of their back. Ventrally, they have some shade of yellow, orange, pink, or red over a white background. The amount of color increases with age.



Columbia spotted frogs, *Rana luteiventris*, showing color on ventral surface.

Juveniles and recently transformed frogs have smaller spots on their back and often lack the color on their belly, having a plain white venter. Good references for identification include Stebbins (2003), Corkran and Thoms (1996), and Werner et al. (2004) - but note that Corkran and Thoms do not distinguish this species from *Rana luteiventris*, so location will have to be taken into account. This is the only aquatic frog present at many locations within its range.

The amount of ventral pigment in the Columbia spotted frog increases with age. **Left:** Juvenile frog. **Right:** Small adult frog.

Site Selection

Without locality data, the selection of a survey site is similar to that for the Oregon spotted frog. Although *Rana luteiventris* occupies a much wider range of habitats, the preferred components are the same: shallow, preferably vegetated areas near some sort of permanent water, which is required for overwintering. Because of the wide variety and dynamic nature of the habitats this species occurs in, it may be found in areas with very little vegetation, such as the margins of rocky streams or the muddy banks of heavily incised creek channels. Remember that "vegetated" is thus a relative term and reflects the preference of the frog, which may not be what is available at a given habitat during a given time.

Nonetheless, when selecting sites at which to look for this species:

1) First, pick areas with some sort of shallow, slow-moving water which is either permanent, or is less than a half-mile (about 800 m) from permanent water.

2) Second, pick sites in which the permanent water fluctuates as little as possible between years, such as a perennial stream, a spring, or a large lake. Although this water source itself may not have spotted frogs year-round, it may support overwintering or late-summer use by frogs that prefer other areas for breeding and active-season habitat.

Following these criteria, examples of suitable sites include: 1) a mountain lake, especially with a seasonal marsh nearby, 2) overflow pools or backwaters of a permanent stream, 3) a long-lasting beaver pond on a temporary stream, 4) vegetated overflow channels of a permanent ground water spring, 5) a seasonally flooded field or temporary wetland with a permanent drainage ditch, 6) a slow, weedy drainage ditch or irrigation canal, 7) a cattle pond a short distance from a river, creek, or irrigation canal.

Give priority to sites with an aquatic connection to occupied areas (e.g., via a river, ditch, or seasonal marsh), or that had a connection to such areas within recent history. Also give priority to sites located within a drainage that has occupied areas, especially if the potential sites are similar in elevation to those occupied. Give lower priority to sites with a heavily managed or irregular hydrology, and more to those that are hydrologically consistent between years.

Timing

As a result of the wide elevation range over which this species occurs, breeding times will vary greatly by location. See the table in the "General Surveys" section of the instruction manual for an example of how to estimate the time of breeding for a given area. Over the region covered here, breeding will occur from March (at the lowest elevation sites) to June (at highest elevations), with breeding in most areas occurring during April and May. As with *Rana pretiosa*, larval development rate varies by site, but generally takes between 70 and 100 days.

Adults become most consistently visible about a month after breeding, and both adult and juvenile frogs can be found from May through August, at most sites. To determine the timing of tadpole surveys, add 1 month to the date of breeding in your area (*e.g.*, breeding in April + 1 month = start tadpole surveys in May).

Remember that, although frogs may be active and visible during summer, this may not be in the same place that breeding occurred, particularly if that site has gone dry. (Hence, the importance of nearby permanent water.) If a breeding site has gone dry, you will have to begin looking at the closest available water to find your frogs.

The best survey times are generally:

Eggs = April (May or June at high elevations)
Tadpoles = late May through June
Frogs = May-August

Survey Methods

Eggs

Spotted frog egg masses are fairly large and easy to see, compared with egg masses of other species (*e.g.*, Northern leopard frog). Despite this, they are not the best life stage on which to base inventory surveys, since they are often concentrated in a small area, and easily overlooked. Egg mass surveys are frequently used for estimating spotted frog population size, or for identifying the exact location of breeding habitat after initial inventory surveys have been performed.

The best place to look for eggs of this species is at the shallow margins of a water body in which frogs have already been found. This may be simply the edge of the same pond where frogs spend the rest of the year, or it may be in flooded marshland ¼ mile or more from the frogs' summer or winter locations. The distance frogs travel to breed will depend on the arrangement of the habitat in a particular area. In general, the best place to begin searching is the shallowest margin that is present during breeding season. For example, if spring flooding causes a lake to overflow 200 m into an adjacent marsh, start searching at the upper (shallowest) margin of that marsh, and work your way back toward the lake. Searching shallow margins may be difficult in large freshwater marshes or flooded fields, which might cover many miles and be fairly uniform in composition. In these cases, there are a few tricks you can use to help narrow your survey area:

First, consider timing. When do these areas have water? Eliminate those that hold water at the wrong time or for too short a period (*e.g.*, that flood for just a few weeks) to support breeding. Second, consider when they fill. Do some habitats fill earlier and thus allow frogs more time to get into them? Is this pattern consistent between years (= more likely to support frogs) or irregular (less likely to support frogs)?

Second, consider location. Start with habitats that are closest to known (or suspected) overwintering areas. Although spotted frogs can move long distances to lay their eggs, they won't if they don't have to. For example, if frogs are found along flowing water (a stream, creek, or drainage ditch) during summer or fall, look for the closest still water to find breeding sites. This may be a beaver pond, a shallow marshy overflow pool, or a wide area created by cattle – as long as it is still water.

Third, look for key features. Spotted frogs prefer to travel in water, so look for potential breeding sites that have an aquatic connection to an overwintering area. Good features include: a permanent pond near (or flooded into) a marsh, a deep ditch or stream channel running through a site, or a nearby spring.

As you narrow your search further, consider the effects of cover. Spotted frogs tend to avoid dense forest when possible, so move your search away from close trees and into more open areas. Within a marsh, frogs prefer breeding in areas of low emergent growth to dense tall strands of cattail, bulrush, or bushes (like *Spiraea*). At an egg-laying site, look for short vegetation and shallow water. Avoid stands of upright cattails, bulrushes, or canary grass, and search in open areas, or look for pockets where tall grass or weeds have laid down.

This is where it pays to be thorough: spotted frogs often lay eggs communally, so the egg masses of an entire population may be piled together at one spot.

Identification: Spotted frog egg masses are grapefruit or softball-sized, and usually found in very shallow water (1.5 feet deep or less). Eggs are simply left on the

bottom, often in pairs or piled together, and not attached to sticks or plants. When you do find eggs, mark the location – frogs often lay eggs in the same place in successive years.

Survey conditions: Egg mass surveys should be conducted during the best light period (0900-1600 hours) of a still, sunny (or partly sunny) day with as little precipitation and wind as possible. Rain and wind disturb the water's surface and make it very difficult to see the clear egg masses, even in shallow water.

Columbia spotted frogs often lay their eggs in the same place.

Left: Eggs are easiest to see during calm and sunny weather. Columbia spotted frog egg mass, Harney Co., OR.

Right: Eggs are difficult to see in overcast or stormy weather. Photo of a group of 20 egg masses.

Examples of spotted frog breeding habitat

A shallow, marshy overflow of an irrigation canal

The weedy backwater of a slow stream

An open pool in a large cattail marsh

Tadpoles

Tadpole surveys for Columbia spotted frogs are conducted in much the same way as for *R. pretiosa.*

To find tadpoles, begin your search in the margins of a site. Look along shallow, heavily vegetated edges of ponds, streams, or slow ditches. If possible, approach sites on land, walking slowly and quietly, and examine the shoreline – tadpoles will often gather in shallow water to feed and warm up, especially as they get older. If no tadpoles are seen (or in larger marshes where bank searching is not possible), wade slowly through the water, watching ahead of you for tadpoles. Wading often scares tadpoles out of hiding and they are easily seen when they flee through open water. Using a dip net, scoop through shallow patches of submerged vegetation. Preferred types includes strands of ruches (*Juncus*, *Eleocharis*) and patches of pondweed (*Potamogeton*).

Columbia spotted frogs exhibit a range of variation in tadpole visibility and development rate between populations, due to differences in elevation and habitat type. For example, tadpoles in shallow pools of an intermittent stream will be much more visible than those in a deep, heavily vegetated spring or irrigation canal. However, since the shallow pools get warmer, the tadpoles in them will transform much more quickly than those in the latter two habitats. Water source and temperature are important to take into account during surveys. This is true even for sites at the same elevation, since source and temperature make a big difference. It is best to time surveys a little early in low elevation, Great Basin habitats.

Surveys should also take into account the effects of weather. In highly variable habitats, such as shallow pools, water temperatures (and tadpole behavior) may sharply track current weather conditions. Spotted frog tadpoles frequently gather in the shallows of a water body, where they are very visible. Most often, this occurs during morning, as water temperatures increase. During cool weather, tadpoles may remain in the shallows through midday. During hot weather, midday temperatures in the shallows may become too warm, and tadpoles will seek shelter in deeper water, in dense vegetation, or among silt and rocks at the bottom, and thus become harder to find. Therefore, surveys in hot weather are best confined to morning or before noon hours for greater success. In contrast, tadpoles in colder water (e.g., snowmelt streams or cool springs) may remain in the shallows during midday, even in hot weather.

Survey conditions: The best time to conduct tadpole surveys is during the highest light period (0900-1700 hours) of a still, warm (65-85°F) day that is at least partly sunny. Under these conditions, tadpoles are usually easiest to find during late morning and late afternoon. Overcast skies and precipitation make it difficult to see into the water.

Tadpoles resemble those of *R. pretiosa* in appearance: Young tadpoles are dark black, grey, or green when young, often with flecks of copper or gold on their sides and belly. Older tadpoles are typically some shade of brown or greenish-brown dorsally, with faint dark spots in the center of the back which get more distinct with age. The belly is off-white, light yellow, or sometimes a mixture of the two. Belly color grades blurrily into the brown of the sides. A large spiral gut is often visible through the skin of the belly. The top of the tail fin begins on the back, not behind it, and the eyes of the tadpole do not protrude beyond the outline of its body, when viewed from above.

Columbia spotted frog tadpoles. **Left:** Newly hatched tadpoles. **Right:** older tadpoles.

Frogs

As with *R. pretiosa*, frogs are typically the easiest life stage of this species to detect consistently. Remember that active-season (summer) habitat may be separate from that used for breeding, and surveys must take this into account to be successful. This also means that frogs moving between seasonal habitats may be encountered in areas that are not typical of those preferred – for example: on roads, along rocky streams, or in a bank hole next to a pool in the bottom of a dry wash. Where water is limited, it may be profitable to identify alternate survey sites (locations with water in the vicinity of your original target site), and search them if frogs are not found at the intended search area – or even if they are.

Especially in arid regions, surveyors should be aware of the possibility that seasonal movements occur in an area, and consider this before drawing inappropriate conclusions (*e.g.*, inferring decline from failure to detect frogs during a visit, or interpreting the finding of a frog or two as constituting an "occupied site"). Furthermore, highly variable sites (such as intermittent streams) should be investigated with respect to their extent and hydrology. What is their source? Their typical annual hydrology? Surveys of the entire stream course and off-channel habitat, and/or multiple visits over the course of a year, may be necessary to consistently find frogs. It is a novice mistake to visit a single site on a creek and assume any sort of trend based on your success or failure at finding frogs during one visit.

Survey conditions for highest detectability should be: still air or light breeze, sunny or partially sunny conditions and warm temperatures (air temperature = 70-85°F).

The best times to survey are between 0900 and 1700 hours daily, during the period of May – August. (The daily period of highest visibility will depend on temperature and water conditions, but will fall within this interval.)

Spotted frogs are highly aquatic, and are almost never found far from water, under the survey conditions described. Surveys for spotted frogs should focus on the bank and near-shore areas of quiet water. As with tadpoles, a quiet approach from land will scare the fewest frogs and increase your success rate. Along the bank, it is usually best to look in the water first, as this is where most frogs will be seen at any given time. Favorite places of Columbia spotted frogs are: in shallow water among patches of rushes, atop grass or sedges that are flattened down in shallow water or are shallowly covered with water, and in mats of floating aquatic vegetation or algae.

Often, smaller frogs will sit entirely on top of floating weeds or flattened, submerged grass, while larger frogs will submerge themselves in such cover, with only their eyes and nose above water. In these situations, the coloration of the spotted frog allows it to conceal itself quite well, and you will have to look very carefully to see them.

Spotted frogs are generally sluggish and rely primarily on their coloration to avoid capture. They are easy frogs to catch (see "Capture and Handling" in the instruction manual), if you approach slowly and carefully. In deep water or a vegetation mat that is not too thick, they are best taken with a net. When scared or missed, they will duck beneath the water and swim down – but if the fright is not too severe, they will often reappear nearby after a little while. These are very slippery frogs, especially the adults, but are poor jumpers and thus easily confined in a net. Juveniles are usually found in shallow water and are best caught by hand. Except during periods of cold weather, this species rarely uses cover objects unless they are as least partly submerged (e.g., a log laying out into the water).

When surveying, weather should strongly be considered. At lower elevations in the Great Basin, especially, hot weather should be avoided. It causes frogs to seek shelter (especially at midday and afternoon) and makes them very difficult, if not impossible, to reliably find. This species may on occasion be slightly more wary than *R. pretiosa*, but not by much. Capture methods are the same as for that species. In some situations (such as during inclement weather, after rain, or following the drying of a pond or stream), it may be worthwhile to turn cover objects during a visual survey, though this technique is usually of little value.

Columbia spotted frogs in preferred habitat.

Left: Preferred habitat of Columbia spotted frogs: still water with extensive weed growth.

Above: In the Great Basin, spotted frog habitat may include intermittent streams.

Field survey protocol for the **Columbia spotted frog, *Rana luteiventris***

Equipment

Required

- Waders
- Wading boots
- Dip net
- Data sheet or notebook
- Pencils or waterproof pens
- Camera
- Plastic ruler
- Digital thermometer
- Ziploc bags
- Small jar or clear container
- Drinking water
- GPS

Optional

- Backpack
- Compass
- First aid kit
- Flagging tape
- Hat
- Map
- Measuring tape
- Pocket knife
- Sharpie marker
- Spring scales
- Duct tape
- Specimen jars
- Food
- Field guide
- Collecting supplies
- Flashlight or headlamp
- Fire starters
- Space blanket
- Extra water
- Photography containers
- Garbage bag
- Cloth bag

Preparation

Planning your survey

Conduct surveys at the following times. Remember that frogs generally breed earlier at lower elevations.

Frog surveys: May through early September.
Egg mass (breeding) surveys: April through May.
Tadpole surveys: May through early July.

Check the weather forecast, and try to pick survey days that are:

1. at least partly sunny,
2. with little or no wind
3. for frog surveys, pick warmer days (daytime high temperature of 65 to 85 ^{o}F), for best results

Scouting the site

If possible, scout the survey site beforehand, to determine its location and get an idea of the amount and type of habitat present.

Look for good habitat (see species account), as well as obstacles like deep water, steep banks, and fences. Also look for the easiest way to get in and out of your survey site (long walks are less fun in waders).

Before you survey

Before you leave, assemble your equipment and check to make sure everything is ready, so you don't waste valuable field time. Make sure your camera batteries are charged, and that you have enough drinking water.

Survey instructions

Starting the survey

At the start of a survey, record the following information for each site:

1. **Location**. Include both a description with site, refuge, county, and state, and UTM coordinates of your start point.
2. **Date**. Write out the month name.
3. **Surveyors** present. Write out first and last names.
4. **Time** survey was started. Use 24-hour format.

How to search

For frogs

Conduct your survey by walking **slowly** and **quietly** along the shoreline of a survey site, watching the water's edge and surface for frogs. If you have scouted the area beforehand, try to time your survey so that you are in the best habitat between late morning and noon, which is often a good period to see spotted frogs. In cooler weather, frogs are most visible during the warmest part of the day, usually early afternoon.

Spotted frogs are very aquatic and will be in water most of the time. They often sit in shallow water, usually among weeds. They also hide in patches of grass and weeds along the bank. Check these patches carefully. If they are too thick to see into, rustle them with a net handle and watch for to frogs jump out. These frogs can sometimes be found sitting on the bank (especially small juveniles). When aquatic weeds form mats over the water's surface, check them with binoculars before you get close. Binoculars are also useful for searching the edges of ponds that have no cover.

When you survey, move as quietly as possible. Don't talk loudly, stomp around, or splash. The more disturbance you make, the fewer frogs you will see. Go slowly and check the area as thoroughly as possible. If you scare a frog into the water, wait quietly for a few minutes, or return to the spot after a half-hour or so. Spotted frogs will often re-surface in the same place they dove in.

For tadpoles

Over the survey area covered here, May through early July is the best time to find tadpoles. Look for them by walking or wading slowly around the edges of a survey site. The best habitat is shallow water (less than two feet deep) which is not shaded and has open areas mixed with patches of grass or weeds.

As you move, watch the water ahead of you for tadpoles fleeing your approach. Periodically check submerged weeds or grass for tadpoles by dip netting. Sweep a dip net

rapidly through the weeds or grass several times – tadpoles often escape the first time but are caught in subsequent tries.

For eggs

For Columbia spotted frogs, April is the best time to find eggs. Look in very shallow water: spotted frogs usually lay their eggs in water less than a foot deep. The best places to start searching are open, sunny edges of ponds and marshes, especially if they have short grass or weeds.

Wade slowly and try not to splash or ripple the water, since that makes it hard to see below the surface. Survey during periods of good light. Avoid stormy, overcast, or windy weather. Polarized lenses will help you see beneath the surface. Spotted frog eggs are usually just left on the bottom in very shallow water. Often, many egg masses are laid together in a single pile. When you find eggs in one spot, look carefully; there will often be more nearby.

When you find frogs

Attempt to catch and photograph the first frog of each species detected during a survey. Collect a voucher photograph of each species from each site surveyed.

For each survey site and species, record the following information:

1. **Species.** Use both the common and scientific names, if you know them. If you aren't sure what species you have, don't guess. Write a description of the frog.
2. **Photograph.** Take a picture of the frog as proof you found it and to identify the species, if you aren't sure. For the first frog of each species at a site, always take a photograph, even if you can identify it. (For instructions on taking voucher photographs, see section 4d, "Photography", of the instruction manual.)
3. **Life stage.** Egg, larva (tadpole) or frog
4. **Number.** Record how many frogs you found
5. **Location.** Record the frog's location. Use UTM coordinates and a short written description
6. **Habitat.** Take a photograph of the habitat and write a short description
7. **Time found.** Note the time the frog was found
8. **Notes.** Anything else of interest or importance. For example: was the frog calling? Did you measure it?

Need help with identification? See the instruction manual!

Section 4 has tips on identification and a list of useful field guides for the project zone.

Appendix 2 lists the frog species which occur in the project zone.

At a survey site, if you find more frogs of a species you have already recorded and photographed, you don't need to catch or photograph them. Instead, record the information above. Record new coordinates if frogs are in a different habitat or location than the first ones you saw. If frogs are in a different type of habitat, take a photo of it.

If you find eggs: Record the same information as for frogs, along with a written description of the eggs' size and shape. Include the eggs' location, the depth of water you found them in, and whether they are attached to something, like a stick or plant stem. This information will help identify them. Take photographs of a) the eggs, if possible, and b) of the habitat where you found them.

See section 4 of the instruction manual for directions on how to identify and photograph frog eggs.

If you find tadpoles: DO NOT HOLD THEM IN YOUR HAND!! Remember to use a jar for examining tadpoles. Record the same information as for frogs, along with a written description of the tadpoles. If possible, photograph or collect one for identification.

See section 4 of the instruction manual for directions on how to identify and photograph tadpoles.

Ending the survey

When you stop surveying a site, record the following information:

1. **Time** survey was ended. Use 24-hour format.
2. **Weather** conditions over the survey interval. Describe the average weather conditions.
3. **Typical habitat**.
    a. Write a short description of the average habitat present at the site.
    b. Take a photograph that shows a sample of this habitat type.

After the survey

When you finish for the day, do the following:

1. **Photocopy** your notes and/or enter your data into a database.
2. **Download** your camera and label the photos. One method that makes organization easy is to label each photo with the survey site name, survey date, and a photo number. Camera download software can be set to do this automatically.
3. **Disinfect** your equipment.

Appendix 6: Northern leopard frog, *Rana pipiens*

Introduction

One of the most widely distributed frogs in North America, the leopard frog ranges almost from coast to coast. Like the spotted frogs, it prefers quiet water with abundant emergent vegetation, but unlike them it often ranges far from water. The leopard frog has a much more continuous distribution in the eastern and central United States than in the west, where it appears to be a geologically recent invader. In the eastern U.S., where summertime humidity is greater, the leopard frog is highly terrestrial; in the arid western states, it is more closely confined to water. It is found across an incredible range of elevations, from sea level to near 10,000 feet.

Northern leopard frog, Grant Co., Washington. Photo by Gary Nafis.

Description

A slender, long-legged frog, at home both on land and in the water. Within the study area, this frog may be either brown or bright green dorsally, with large dark spots that have pale (light-colored) borders. This color pattern is unmistakable - no other frog within this protocol area has these large, pale-bordered spots. Juvenile frogs usually resemble adults, but may occasionally lack spots. The venter is bright white, with no mottling or color. This frog is a good jumper and will escape through grass or weeds using a series of irregular, "zig-zag" leaps.

Northern leopard frog: Brown form, brown form, green form, and ventral surface. Photos 2-4 courtesy Gary Nafis.

Site selection

The preferred habitat for *Rana pipiens* consists of quiet (still) water bodies with abundant emergent vegetation and which are surrounded by grassy meadows, freshwater emergent marsh, or open, brushy woods. Lacking occurrence data, the best survey sites will be heavily vegetated permanent wetlands or temporary wetlands near some source of permanent water. Temporary ponds or freshwater marshes in the vicinity of a stream, irrigation ditch, or lake provide excellent habitat. Because leopard frogs often use the same habitat as bull frogs within the survey area, the best sites will either lack bull frogs

or will contain temporary water that leopard frogs can use for breeding but bull frogs cannot.

Priority should be given to sites with hydrologic or riparian connectivity to occupied sites, or to sites within a mile or so of occupied sites (since leopard frogs travel extensively on land during wet weather). Low priority should be given to sites with irregular or highly managed hydrology, sites that are barren of vegetative cover (i.e., heavily dredged or lined irrigation canals or storage reservoirs), rocky streams with few backwater or overflow ponds, and isolated ponds or mountain lakes.

Timing

Because the leopard frog inhabits a wide elevational range, timing of breeding (and other aspects of the life history) will vary. The table in the "General Surveys" section lists the predicted time of breeding by refuge. Over most of the survey area, leopard frog breeding will probably occur from April through May (earlier at lower elevations and later at higher elevations). Breeding generally lasts several weeks at a given location, and it may go longer in areas where the frog population is large or the site is physically or hydrologically complex. As with spotted frogs, tadpoles' growth rate is temperature-dependent and thus varies by site, but larvae generally transform in 60-100 days. The best detectability of tadpoles is generally from one month after spawning until transformation, or from about late May through June over much of the survey area. The best detectability of transformed frogs (mostly juveniles) is from July until September over most of the study area, and this is the time to conduct visual surveys.

Survey Methods

Eggs

Egg masses of northern leopard frogs are not as easy to find as those of spotted frogs. This is because leopard frog egg masses are smaller than those of spotted frogs, and are often located among dense vegetation. For these reasons, eggs are not the best life stage on which to base inventory surveys. The best way to find egg masses of this species is to visit an occupied pond during the breeding season, and listen for the calls of male frogs. Males often form a breeding chorus in south-facing or protected portions of a pond, and eggs masses will usually be laid in the general vicinity of a chorus. When visiting a place in which a chorus has not been observed, search the same areas: south-facing and protected areas that warm quickly. Egg masses are usually laid among submerged grass or weeds. When you find one, search carefully – leopard frogs often lay egg masses close together, so there may be more nearby.

Leopard frog breeding habitat.

Survey conditions: Even more so than with spotted frogs, ideal survey conditions for the eggs of this species are sunny, calm days during the period of best lighting – approximately 1000-1600 hours. Poor lighting or water movement can make it very difficult to see beneath the surface in the areas where these frogs lay their eggs.

***Identification*:** Egg masses of this species are rounded, irregular, and roughly oblong, or sometimes with a "flattened" oval shape. The mass jelly often has a slightly opaque, bluish or gray cast. The individual eggs are smaller than those of spotted frogs, and the mass has a tendency to accumulate silt and debris, giving it a "dirty" or "ragged" look, in contrast to the smooth, globular-looking masses of spotted frogs.

Tadpoles

Tadpoles of this species inhabit densely vegetated and algae-filled waters and can be very difficult to see. They are not too hard to catch, however, if you are quick and persistent with a dip net. The best way to survey for tadpoles of this species is to approach a target site quietly from land. Although it can be nearly impossible to see larvae of this species from the bank, the objective in approaching quietly is not to scare them into deeper water or dense vegetation and thus make them more difficult to catch. If you have to wade, wade quietly, watching open water in front of you for fleeing tadpoles. Sometimes, wading in deeper water (knee- to thigh-deep) and then approaching a likely looking spot along the shore will allow you to scare tadpoles into the shallows and make them easier to catch.

When dip-netting, avoid a slow, half-hearted sweep, as leopard frog larvae are fast swimmers. Instead, net vigorously: when you find a good-looking area, such as a dense patch of submerged aquatic vegetation, aim for the bottom of it. Jab your net in rapidly, push it forward as far as you can (using the two-handed grip described earlier – see "Capture and Handling" section), then sweep it quickly towards the surface. Check contents, dump them out if you have no tadpoles, and quickly net again. Keep netting rapidly until you have either caught tadpoles or are satisfied that you have covered the area thoroughly.

***Survey conditions*:** Because, in most situations, you will have to dip net to find larvae, it is not absolutely essential whether they are active (or hiding in weeds) during your survey. Therefore, surveys for this species can be conducted during slightly cooler (60°F) and/or overcast weather if necessary.

***Identification*:** Tadpoles of this species are brownish-gray dorsally, with irregular, "metallic"-looking flecks on the back and sides. Their belly is a silvery or "dirty" off-white in color, sometimes almost clear. Belly color grades irregularly into blotched sides. The front of the top edge of the tail fin barely extends onto the back, and the eyes do not protrude beyond the body outline when viewed from above. Stebbins (2003), Werner et al. (2004), and Corkran and Thoms (1996) are good identification guides for the eggs and larvae of this species.

Frogs

By far, frogs are the easiest life stage of this species to detect. In general, surveys for this species can be conducted under the same weather conditions (still, 70-90°F air temperature, sunny or partly cloudy) as for spotted frogs, though a few differences apply:

First, the leopard frog is much more terrestrial in its habits than the spotted frog, and a large percentage of the frogs encountered at a given site during a survey may be on land. These frogs are often wary, and on approach of a surveyor, leap rapidly into the water and dive for the bottom, or flee deep into tall weeds or thick brush. Second, because this species is more terrestrial, wet weather allows them to move away from the water's edge, and they may disperse widely during or after a rain. This movement reduces the number of frogs concentrated around a target site and make them harder to find. Therefore, surveys for this species will have greater success if they:

1) Concentrate on the land area around the pond, rather than just the water itself. In hot or dry weather, many of these frogs will be in the water or immediately at the edge, especially if there are thick patches of reeds or grass to hide in. But on most surveys, a surprising number of these frogs will be several meters or more up the bank, hiding in grass or holes in the bank. Turning cover objects near the water is more useful when looking for this species than when looking for spotted frogs, especially after metamorphosis (late summer), when large numbers of juvenile frogs are present.

2) Avoid surveying permanent or standing water bodies during or immediately after a rain. The frogs will often move away from the pond and be very hard to find using the standard "bank-walking" approach. On the other hand, as habitat begins to dry out after a rain, frogs begin moving back towards water, but are still very active, so they are often very easy to find. Thus, a little while after a rain is a good time to search. If you do search during a rain, look in brush around ponds and on creek banks, and road-hunt. Rainy weather is the best time to find frogs and toads by road-hunting.

Leopard frogs may be found on land (**top**) and in the water (**bottom**).

Photos by Gary Nafis.

As mentioned previously, leopard frogs are faster than spotted frogs and harder to catch. On land, a net is generally useless. Catch them by hand in thick weeds. After you have seen a few jump, you will learn their "zig-zag" hopping pattern and be able to catch them more easily. In water, a net is useful for frogs that are floating or swimming in deeper areas.

A few tips:

1) Leopard frogs scared into water or which dive beneath water will often re-surface after a few minutes, if they are not scared too badly. Immediately after they pop back up is a good time to get them with a net. Watch a few and learn to anticipate this.

2) Leopard frogs are good jumpers, and all but the smallest will easily fly out of an average dip net. To prevent this, either use a deeper net, or shake the net gently once the frog is in it. Continuous shaking of the net bag while the frog is inside will prevent the frog from getting a stable footing and jumping out.

3) If you find that, for whatever reason, you are just not good at catching leopard frogs, learn to approach carefully so that you can see them without scaring them. The spotting pattern and jumping habit of leopard frogs are distinctive and often allow you to identify the species without actually catching them. In many situations, you can approach closely enough to get a voucher photo, if you have a good telephoto lens.

Preferred leopard frog habitat: a weedy pond surrounded by thick rushes.

Leopard frogs are often found in grassy meadows adjacent to ponds.

Ponds surrounded by marshes or thick vegetation are used by leopard frogs, even in arid regions.

Field survey protocol for the **Northern leopard frog, *Rana pipiens***

Equipment

Required

- Waders
- Wading boots
- Dip net
- Data sheet or notebook
- Pencils or waterproof pens
- Camera
- Plastic ruler
- Digital thermometer
- Ziploc bags
- Small jar or clear container
- Drinking water
- GPS

Optional

- Backpack
- Compass
- First aid kit
- Flagging tape
- Hat
- Map
- Measuring tape
- Pocket knife
- Sharpie marker
- Spring scales
- Duct tape
- Specimen jars
- Food
- Field guide
- Collecting supplies
- Flashlight or headlamp
- Fire starters
- Space blanket
- Extra water
- Photography containers
- Garbage bag
- Cloth bag

Preparation

Planning your survey

Conduct surveys at the following times. Remember that frogs generally breed earlier at lower elevations.

Frog surveys: May through early September.
Egg mass (breeding) surveys: April through May.
Tadpole surveys: May through early July.

Check the weather forecast, and try to pick survey days that are:

1. at least partly sunny,
2. with little or no wind
3. for frog surveys, pick warmer days (daytime high temperature of 65 to 85 ^{o}F), for best results

Scouting the site

If possible, scout the survey site beforehand, to determine its location and get an idea of the amount and type of habitat present.

Look for good habitat (see species account), as well as obstacles like deep water, steep banks, and fences. Also look for the easiest way to get in and out of your survey site (long walks are less fun in waders).

Before you survey

Before you leave, assemble your equipment and check to make sure everything is ready, so you don't waste valuable field time. Make sure your camera batteries are charged, and that you have enough drinking water.

Survey instructions

Starting the survey

At the start of a survey, record the following information for each site:

1. **Location**. Include both a description with site, refuge, county, and state, and UTM coordinates of your start point.
2. **Date**. Write out the month name.
3. **Surveyors** present. Write out first and last names.
4. **Time** survey was started. Use 24-hour format.

How to search

For frogs

Conduct your survey by walking **slowly** and **quietly** along the shoreline of a survey site, watching the water's edge and surface for frogs. Leopard frogs tend to be aquatic during dry weather and terrestrial under moist conditions. They are often found:

a) sitting on the bank among weeds,
b) in shallow water, or
c) floating at the surface with only their eyes showing, especially where aquatic weeds form mats over the water's surface.

Check weed mats with binoculars before you get close. Binoculars are also useful for searching the edges of ponds that have no cover. Leopard frogs like to hide in patches of grass and weeds along the bank. Check these patches carefully. If they are too thick to see into, rustle them with a net handle and watch for to frogs jump out.

When soil and vegetation are moist, leopard frogs will go a long way from water. Search at least ten meters from the shore during wet conditions; look farther away if there is good cover (grass, sedges, or weeds).

When you survey, move as quietly as possible. Don't talk loudly, stomp around, or splash. The more disturbance you make, the fewer frogs you will see. Go slowly and check the area as thoroughly as possible. If you scare a frog into the water, wait quietly for a few minutes: if the frog was not scared too badly, it will often return to the surface.

For tadpoles

Over the survey area covered here, May through early July is the best time to find tadpoles. Look for them by walking or wading slowly around the edges of a survey site. The best habitat is shallow water (less than two feet deep) which is not shaded and has open areas mixed with patches of grass or weeds.

As you move, watch the water ahead of you for tadpoles fleeing your approach. Periodically check submerged weeds or grass for tadpoles by dip netting. Sweep a dip net rapidly through the weeds or grass several times – tadpoles often escape the first time but are caught in subsequent tries.

For eggs

For leopard frogs, April and May are the best times to find eggs. Look in shallow water, from about six inches to two feet deep. The best places to start searching are open, sunny edges of ponds and marshes, especially near flooded stands of weeds or brush.

Wade slowly and try not to splash or ripple the water, since that makes it hard to see below the surface. Survey during periods of good light. Avoid stormy, overcast, or windy weather. Polarized lenses will help you see beneath the surface. Leopard frog eggs are laid in a mass, which may be stuck in weeds or just left on the bottom. When you find eggs in one spot, look carefully; there will often be more nearby.

When you find frogs

Attempt to catch and photograph the first frog of each species detected during a survey. Collect a voucher photograph of each species from each site surveyed.

For each survey site and species, record the following information:

1. **Species.** Use both the common and scientific names, if you know them. If you aren't sure what species you have, don't guess. Write a description of the frog.
2. **Photograph.** Take a picture of the frog as proof you found it and to identify the species, if you aren't sure. For the first frog of each species at a site, always take a photograph, even if you can identify it. (For instructions on taking voucher photographs, see section 4d, "Photography", of the instruction manual.)
3. **Life stage.** Egg, larva (tadpole) or frog
4. **Number.** Record how many frogs you found
5. **Location.** Record the frog's location. Use UTM coordinates and a short written description
6. **Habitat.** Take a photograph of the habitat and write a short description
7. **Time found.** Note the time the frog was found
8. **Notes.** Anything else of interest or importance. For example: was the frog calling? Did you measure it?

Need help with identification? See the instruction manual!

Section 4 has tips on identification and a list of useful field guides for the project zone.

Appendix 2 lists the frog species which occur in the project zone.

At a survey site, if you find more frogs of a species you have already recorded and photographed, you don't need to catch or photograph them. Instead, record the information above. Record new coordinates if frogs are in a different habitat or location than the first ones you saw. If frogs are in a different type of habitat, take a photo of it.

If you find eggs: Record the same information as for frogs, along with a written description of the eggs' size and shape. Include the eggs' location, the depth of water you found them in, and whether they are attached to something, like a stick or plant stem. This information will help identify them. Take photographs of a) the eggs, if possible, and b) of the habitat where you found them.

See section 4 of the instruction manual for directions on how to identify and photograph frog eggs.

If you find tadpoles: DO NOT HOLD THEM IN YOUR HAND!! Remember to use a jar for examining tadpoles. Record the same information as for frogs, along with a written description of the tadpoles. If possible, photograph or collect one for identification.

See section 4 of the instruction manual for directions on how to identify and photograph tadpoles.

Ending the survey

When you stop surveying a site, record the following information:

1. **Time** survey was ended. Use 24-hour format.
2. **Weather** conditions over the survey interval. Describe the average weather conditions.
3. **Typical habitat**.
    a. Write a short description of the average habitat present at the site.
    b. Take a photograph that shows a sample of this habitat type.

After the survey

When you finish for the day, do the following:

1. **Photocopy** your notes and/or enter your data into a database.
2. **Download** your camera and label the photos. One method that makes organization easy is to label each photo with the survey site name, survey date, and a photo number. Camera download software can be set to do this automatically.
3. **Disinfect** your equipment.

Appendix 7: Western toad, *Bufo boreas*

Introduction

Western toad (*Bufo boreas*). Stevens Co., Washington

This large toad occupies a variety of habitats over a wide range of elevations in the western U.S. It is the only toad present over much of the Pacific Northwest. In some areas, it is easily found; at others, its secretive nature makes it difficult to observe, especially where population densities are low and/or vegetative cover is dense. Western toads are terrestrial, and their life history is strongly influenced by local conditions. Because of this, they are more difficult to find consistently than the other frogs described here.

Description

The short, stubby legs and dry, bumpy skin of this species identify it unmistakably as a toad. Determination of species is possible via the presence of a light yellow or white dorsal stripe found on most specimens, the lack of cranial crests behind the eyes (present in Woodhouse's toad), and capture location.

Western toads are variable in color: they are typically some shade of brown or gray, but may also be green, red, yellow, black, multicolored, or marbled with white. Therefore, color alone is not a good identifying characteristic. Ventrally, this toad is typically dirty white or gray, often with darker mottling. Newly transformed toadlets and small juveniles of this species have bright yellow or orange pads on the soles of their feet.

Left: Color variation in adult toads. **Center**: Juvenile toads have orange on the soles of their feet. **Right**: Toad secreting poison.

Site Selection

Difficult. Western toads occupy a wide variety of habitats. Toads can survive in much drier areas than most frogs, and can travel a long way from water. About the only thing required to support a breeding toad population is the presence of still or slowly moving fresh water for two months or more during the spring or summer. Toads also live longer than many frogs, and do not have to successfully reproduce each year to maintain a population.

When surveying for toads, start by looking for a body of water that is present for at least two months between April and August. Within this interval, May and June are usually peak months for breeding, so give priority to water that is present then. The best water bodies will be slow-moving and will not fluctuate too rapidly in level. The type of water body is less important, as long as it is not too swiftly moving – western toads will breed in many different types of habitats. Finally, give priority to sites that have some form of cover nearby (within ½ mile – closer is better). Types of cover may include forest, stands of woods, thick shrubs (e.g., sagebrush), rodent burrows, brushy fencerows, rock slides, *etc*.

Avoid areas that are far from cover of any sort, excessively barren, or where surrounding terrestrial habitat is developed or heavily disturbed. Avoid water bodies that are very shallow, irregular or transitory in nature (some irrigation reservoirs and canals, vernal pools, *etc*.). With western toads, failure to detect animals during a survey is much less indicative of an actual absence than with other species covered here. If the habitat seems good, repeat surveys are strongly recommended.

Timing

Like site selection, this will be far more difficult for western toads than for the three species of ranid frogs covered previously. This is because toads generally prefer to lay eggs in warmer water than do the frogs, and exactly when that warmer water appears at a given site will vary dramatically, as a function of both elevation and water source. For example, toads at low elevations generally breed earlier than those at high elevations. However, in some areas, toads dependent on snowmelt runoff for breeding habitat will actually breed later at lower elevations than higher ones in the same vicinity, since they have to wait for water to be present and sufficiently warm where they are. This phenomenon has been reported from the Snake River canyon by Nussbaum *et al*. (1983) and Llewellyn and Peterson (1998), and I have observed it in the Santiam River basin of western Oregon.

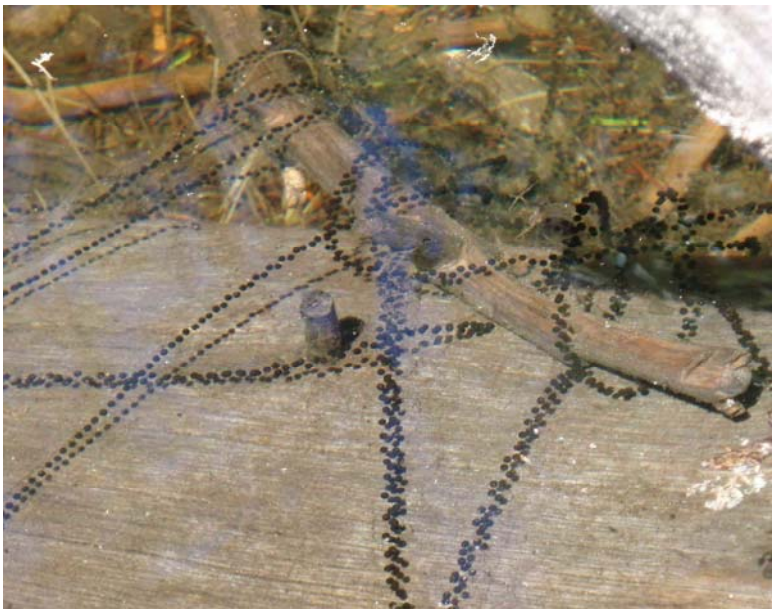
Therefore, without knowing the physical and hydrologic characteristics of a given site, it is difficult to predict exactly when western toad breeding will occur (based solely on elevation). However, tadpoles and recently transformed juveniles of this species are easy to observe and identify during visual surveys, so knowing the exact timing of breeding at a site is not necessary for inventory surveys. Western toad adults and juveniles are most easily observed during their active season, which ranges from just before breeding to late summer: April through August, over most of the survey area. Within this interval, peak activity times are generally during late spring, and following mid- and late-summer rains.

Survey Methods

Eggs

Eggs of western toads are extremely distinctive, and not particularly difficult to find, but are the worst life stage to use for inventory purposes because they hatch very quickly, and so are present for only a short time. The most effective way to survey for eggs is to visit a site known or suspected to be occupied by toads, at the time when toads are suspected to be breeding (e.g., based on site knowledge and records of breeding in similar or nearby habitats). Sometimes, a group of male toads will be present, indicating the location of a breeding site. Such toads often sit quietly on the bank or on the rocks or logs in the water. During the peak of breeding, they may swim or float at the water's surface. Breeding sites are typically in sheltered, south-facing locations, which are usually shallow and often have submerged, aquatic vegetation or woody debris as cover. Although male toads may hang around the breeding site for a while, the actual period of spawning can be quite short – in an Oregon population which I observed for several years, most spawning by 50-100 female toads was completed within a period of approximately one week.

Identification: As previously mentioned, eggs of this species are quite distinct: they are laid in long strings, each of which is wrapped loosely around sticks, rocks, plants, or other objects in the environment. Stebbins (2003) and Corkran and Thoms (1996) are good identification guides for this species.



Left: Western toad egg strings in water.

Right: Close-up of egg string.

Tadpoles

Larvae of this species are very distinctive. They are black, grow up to about 1.5 inches in length, and swim slowly (compared to frog tadpoles). They have a tendency to stay together in a large school, which may include many thousands of individuals. These features make them fairly easy to find during a visual search. To locate them, target shallow margins of water bodies, in the same manner you would use to look for breeding sites (i.e., pick areas that are south-facing, protected, and not far from terrestrial cover). Walking quietly along (or through) suitable habitat will often disclose their location.

These larvae develop fairly rapidly, and most transform in about 1.5 – 3 months, depending on location and water temperature. They are most visible beginning about two weeks after hatching through metamorphosis. (Recently transformed metamorphs, or juveniles, are often very visible – see below).

Survey conditions: The best time to see these tadpoles is late morning (0900-1000) through afternoon (1600), on days which are warm but not too hot (70 - 90°F daytime high air temperature), using bank-walking survey methods described previously for spotted frogs.

Western toad tadpoles are very distinctive.

Above: Toad tadpole, life size.

Top left: School of toad tadpoles.

Bottom left: Close-up of school.

vey methods

Toads

Adults of this species are less *consistently* detectable than adults of the three frog species previously described. This is primarily due to their terrestrial nature; since they are not restricted to the immediate vicinity of water, they can "spread out" over a much larger area and thus be harder to find. The implication of this is that surveys will find frogs more quickly than toads, and surveys may have to be repeated several times at a site (where toads are present) before they are found. Consequently, failure to detect toads during a survey or two at a given site may not represent an actual absence of toads from that site.

Despite all this, there are a number of methods which will greatly increase your success at detecting toads. The most important of these is survey timing. There are three best times (and places) to look for toads.

The ***first*** is during the spring breeding season. As previously mentioned (see "eggs" section), adult toads (especially males) will gather in the vicinity of a breeding site at this time. Although the actual duration of spawning may be quite short, some adults often hang around for a while and can be found during daytime visual surveys of the shoreline and vicinity, as has been described for the spotted and leopard frogs. Since toads generally breed later than frogs at a given site, daytime surveys of this type can sometimes be combined with surveys for frog tadpoles and adults.

Male toad at breeding site.

The ***second*** best time to find toads is during their summ period between breeding and when the toads become inactive for the fall/winter. Generally, this occurs during the summer months (from June though August, over most of the area covered by this protocol). In lower-elevation areas where toads breed late (e.g., in July, following snowmelt runoff), they will become active several months before breeding, and resume their 'normal' activity for a month or two afterward. The best way to conduct surveys during the active season is by 1) visual searching (best during dry weather) and 2) road-hunting (best during or immediately after a rain).

1) Visual searching can be conducted during either daytime or nighttime. Night surveys cover less ground but can be more effective, if the area is familiar. To do this, walk the banks of water bodies after dark, giving special attention to shallow areas: toads often visit water after dark, to catch food and to re-hydrate. Another good area to search is in the vicinity of lights: porch lights, barn lights, lights on outbuildings, etc. Anywhere a light is surrounded by potential habitat is a likely place. Toads often visit lights after dark in order to catch the insects that are drawn to them.

Visual searching during daytime can be conducted in any suitable habitat, but is usually most effective if done in the vicinity of water. Searches may be performed in the same manner as for frogs, but should include an area farther up the bank – several meters or more (≥10m) if cover is good. Since toads usually hide during the day, it is important to look in all forms of cover. Thrash thick weeds with a stick or net handle to see if anything moves. Look in brush piles, flip bark, look under rocks and logs, check rodent burrows and holes in the bank with a pocket flashlight. Watch along the shore –

occasionally toads will sit at the surface, beneath a bush or near a clump of weeds, catching bugs near the water.

Left: Western toad at pond edge.

Right: Young toad in rotting log.

2) Road-hunting is most effective during or immediately after a rain, when toads are actively moving about on the surface. It is done as described in the instruction manual – by driving slowly through prospective habitats (in the vicinity of water or at the edges of forest or woods, especially where they border fields or open areas, are good spots). Near water is especially good during the first fall rain, when juveniles toads disperse away from their breeding sites in large numbers.

The ***third*** best time to find toads is during late summer, immediately after tadpoles have completed metamorphosis. At this time, large concentrations of small juveniles ("toadlets") can be found around the edges of breeding sites. Depending on the amount of cover and soil moisture in the surrounding habitat, these small toads may disperse within a week or two, or remain near their breeding site for up to a month. Upon the arrival of the first late summer or fall rain, they will leave the water and disperse widely into the surrounding habitat. While they are present near water, they are very visible and easy to detect during daytime visual surveys.

Newly transformed toadlets can be found near breeding sites.

Examples of western toad breeding habitat. Clockwise from top right: Weedy drainage ditch (1,800 feet elevation), Brownlee Reservoir (2,050 feet), overflow of Kootenai River (1,700 feet), backwater of coastal river (30 feet), small pond in Cascade Mountains (5,100 feet), floodplain lake of lower Columbia River (35 feet).

Field survey protocol for the **Western toad, *Bufo boreas***

Equipment

Required

- Waders
- Wading boots
- Dip net
- Data sheet or notebook
- Pencils or waterproof pens
- Camera
- Plastic ruler
- Digital thermometer
- Ziploc bags
- Small jar or clear container
- Drinking water
- GPS

Optional

- Backpack
- Compass
- First aid kit
- Flagging tape
- Hat
- Map
- Measuring tape
- Pocket knife
- Sharpie marker
- Spring scales
- Duct tape
- Specimen jars
- Food
- Field guide
- Collecting supplies
- Flashlight or headlamp
- Fire starters
- Space blanket
- Extra water
- Photography containers
- Garbage bag
- Cloth bag

Preparation

Planning your survey

Conduct surveys at the following times:

Toad surveys: May through early September (July and August for transforming juveniles)

Egg mass (breeding) surveys: April through July

Tadpole surveys: May through August

Check the weather forecast, and try to pick survey days that are:

1. at least partly sunny (clear skies are ok, but partly cloudy is often best)
2. warm but not hot (predicted daytime high temperature is between 65 and 85 ^{o}F)
3. with little or no wind

If the weather is warm enough ($\geq$70 ^{o}F), surveys during or immediately following rain are often successful, since moisture usually makes toads more active.

Scouting the site

If possible, scout the survey site beforehand, to determine its location and get an idea of the amount and type of habitat present.

Look for good habitat (see species account), as well as obstacles like deep water, steep banks, and fences. Also look for the easiest way to get in and out of your survey site (long walks are less fun in waders).

Before you survey

Before you leave, assemble your equipment and check to make sure everything is ready, so you don't waste valuable field time. Make sure your camera batteries are charged, and that you have enough drinking water.

Survey instructions

Starting the survey

At the start of a survey, record the following information for each site:

1. **Location**. Include both a description with site, refuge, county, and state, and UTM coordinates of your start point.
2. **Date**. Write out the month name.
3. **Surveyors** present. Write out first and last names.
4. **Time** survey was started. Use 24-hour format.

How to search

For toads

Adult toads are terrestrial and nocturnal. Surveys for them must concentrate on their hiding places. **Juvenile toads** are frequently seen during the day, especially right after transformation (below).

Conduct surveys by walking **slowly** and **quietly** around a survey site, watching the bank near the shore, especially where there is cover (logs, undercut banks or thick patches of weeds) that comes close to the water. Check shoreline patches of grass and reeds by carefully looking through them. Unlike frogs, toads often remain still when disturbed.

Look under cover. Turn basically anything you can move that is within 20 m of the water, or farther (especially if the soil is moist and there are woods or forest nearby). Toads will go a long way from water. Look under rocks and logs, loose pieces of bark, trash, mats of vegetation, etc. You will have the most success when the soil underneath a cover object is slightly moist to the touch. As the soil begins to dry out, stop turning and move back toward water. Also check thick patches of grass or weeds, dark areas underneath bushes, rodent burrows and undercut banks along streams or ditches.

Searching around water that has recently dried (pools, ditches, and the like) is a good way to find toads. Just after transformation, juvenile toads can be found around the edges of water bodies (even dry ones) in large numbers. They are very small, so look closely.

For tadpoles

Over the survey area covered here, June through early August is the best time to find tadpoles. Look for them by walking or wading slowly around the edges of a survey site. The best habitat is shallow water (less than three feet deep) which is not shaded.

As you move, watch the water ahead of you for tadpoles. Western toad tadpoles are very easy to see: they are jet black in color, swim slowly, and form large schools. They swim during the day and rarely hide; they are easily captured by dip netting.

For eggs

Toad eggs can be found between April and July. They are usually in very shallow water (less than a foot deep), and can often be seen from the bank. The best places to start searching are open, sunny edges of ponds, lakes, and slow margins of streams. Toads often lay eggs along

Wade slowly and try not to splash or ripple the water, since that makes it hard to see below the surface. Survey during periods of good light. Avoid stormy, overcast, or windy weather. Polarized lenses will help you see beneath the surface. Leopard frog eggs are laid in a mass, which may be stuck in weeds or just left on the bottom. When you find eggs in one spot, look carefully; there will often be more nearby.

When you find toads

The first time you find a toad, catch it. Record the following information:

1. **Species.** Use both the common and scientific name for the first toad, and for the first of any other frog species. If you find a frog you can't identify, don't guess. Write a description of the frog.
2. **Photograph.** Take a picture of the toad.
3. **Life stage.** Egg, larva (tadpole) or toad
4. **Number.** Record how many frogs you found
5. **Location.** Record the frog's location. Use UTM coordinates and a short written description
6. **Habitat.** Take a photograph of the habitat and write a short description
7. **Time found.** Note the time the frog was found
8. **Notes.** Anything else of interest or importance. For example: was the frog calling? Did you measure it?

Need help with identification? See the instruction manual!

Section 4 has tips on identification and a list of useful field guides for the project zone.

Appendix 2 lists the frog species which occur in the project zone.

At a survey site, if you find more frogs or toads of a species you have already recorded and photographed, you don't need to catch or photograph them. Instead, record the information above. Record new coordinates if frogs are in a different habitat or location than the first ones you saw. If frogs are in a different type of habitat, take a photo of it.

If you find eggs: Record the same information as for frogs, along with a written description of the eggs' size and shape. Include the eggs' location, the depth of water you found them in, and whether they are attached to something, like a stick or plant stem. This information will help identify them. Take photographs of a) the eggs, if possible, and b) of the habitat where you found them.

See section 4 of the instruction manual for directions on how to identify and photograph frog eggs.

If you find tadpoles: DO NOT HOLD THEM IN YOUR HAND!! Remember to use a jar for examining tadpoles. Record the same information as for frogs, along with a written description of the tadpoles. If possible, photograph or collect one for identification.

See section 4 of the instruction manual for directions on how to identify and photograph tadpoles.

Ending the survey

When you stop surveying a site, record the following information:

1. **Time** survey was ended. Use 24-hour format.
2. **Weather** conditions over the survey interval. Describe the average weather conditions.
3. **Typical habitat**.
    a. Write a short description of the average habitat present at the site.
    b. Take a photograph that shows a sample of this habitat type.

After the survey

When you finish for the day, do the following:

1. **Photocopy** your notes and/or enter your data into a database.
2. **Download** your camera and label the photos. One method that makes organization easy is to label each photo with the survey site name, survey date, and a photo number. Camera download software can be set to do this automatically.
3. **Disinfect** your equipment.

Appendix 8: Sample Datasheets

The following two pages have examples of data sheets designed for a general amphibian survey.

AMPHIBIAN SURVEY DATA SHEET

DATE: ____________ LOCATION:____
Site/Refuge County State

Surveyors:____ **Site Photo:** Yes No **Photo #:**________

Start Time:_________ End Time:__________ WEATHER:_______________________________

Weather: sunny partly sunny cloudy **Wind**: still light breeze strong breeze windy **Rain**? Yes No **Air Temp.:** ______ °F °C

 # Time Species Life Stage Location/Habitat

Notes:

Photo: Yes No **Photo #:**________ **Type:**________________

Notes:

Photo: Yes No **Photo #:**________ **Type:**________________

Notes:

Photo: Yes No **Photo #:**________ **Type:**________________

Notes:

Photo: Yes No **Photo #:**________ **Type:**________________

Notes:

Photo: Yes No **Photo #:**________ **Type:**________________

Notes:

Photo: Yes No **Photo #:**________ **Type:**________________

Notes:

Photo: Yes No **Photo #:**________ **Type:**________________

Notes:

Photo: Yes No **Photo #:**________ **Type:**________________

Notes:

Photo: Yes No **Photo #:**________ **Type:**________________

Notes:

Photo: Yes No **Photo #:**________ **Type:**________________

Amphibian Survey Data Sheet

Date:_____ Location:_____ Surveyors:_____

Start time:_____ End Time:_____

Weather: sunny partly sunny cloudy **Wind:** still light breeze strong breeze windy **Rain?** Yes No **Air Temp.:___** ^{o}F ^{o}C

#	Time	Species	Life stage	Location	Habitat	Notes
1.						
2.						
3.						
4.						
5.						
6.						
7.						
8.						
9.						
10.						
11						
12.						
13.						
14.						
15.						
16.						