National Park Service
U.S. Department of the Interior

Natural Resource Stewardship and Science

Cooperative Amphibian Monitoring Protocol for the Greater Yellowstone Network

Standard Operating Procedures, Version 1.0

Natural Resource Report NPS/GRYN/NRR—2013/655

ON THE COVER
Amphibian monitoring crew training, 2011
Photograph by: Debra Patla

Cooperative Amphibian Monitoring Protocol for the Greater Yellowstone Network

Standard Operating Procedures, Version 1.0

Natural Resource Report NPS/GRYN/NRR—2013/655

Amphibian Monitoring Working Group*

Robert Bennetts[1], Stephen Corn[2], Rob Daley[3], William R. Gould[4], Cathie Jean[3], Debra A. Patla[5,6], Charles R. Peterson[5], and Andrew Ray[3]

[1]NPS Southern Plains Inventory & Monitoring Network
Lora M Shields Science Building
New Mexico Highlands University
Las Vegas, New Mexico 87701

[2] USGS Northern Rocky Mountain Science Center
Aldo Leopold Wilderness Research Institute
PO Box 8089
Missoula, Montana 59807

[3]NPS Greater Yellowstone Inventory and Monitoring Network
2327 University Way, Suite 2
Bozeman, Montana 59715

[4]Applied Statistics Program
New Mexico State University
P.O. Box 30001, MSC 3CQ
Las Cruces, New Mexico 88003

[5]Department of Biological Sciences
Herpetology Laboratory
Idaho Museum of Natural History
Idaho State University
Pocatello, Idaho 83209-8046

[6]Northern Rockies Conservation Cooperative
185 Center Street, Suite C/D
PO Box 2705
Jackson, Wyoming 83001

*****The above authors developed this protocol collaboratively as part of the Amphibian Monitoring Working Group; authors are listed in alphabetical order.

April 2013

U.S. Department of the Interior
National Park Service
Natural Resource Stewardship and Science
Fort Collins, Colorado

The National Park Service, Natural Resource Stewardship and Science office in Fort Collins, Colorado, publishes a range of reports that address natural resource topics. These reports are of interest and applicability to a broad audience in the National Park Service and others in natural resource management, including scientists, conservation and environmental constituencies, and the public.

The Natural Resource Report Series is used to disseminate high-priority, current natural resource management information with managerial application. The series targets a general, diverse audience, and may contain NPS policy considerations or address sensitive issues of management applicability.

All manuscripts in the series receive the appropriate level of peer review to ensure that the information is scientifically credible, technically accurate, appropriately written for the intended audience, and designed and published in a professional manner.

This protocol uses methods based on an established peer-reviewed protocol. Additional formal peer review was received by a subject-matter expert not directly involved in the development of the sample design and sample size analysis, and whose background and expertise put them on par technically and scientifically with the authors

This report is available from the Greater Yellowstone Network website (http://science.nature.nps.gov/im/units/gryn/), the Integration of Natural Resource Management Applications website (https://irma.nps.gov/), and the Natural Resource Publications Management website (http://www.nature.nps.gov/publications/nrpm/).

Please cite this publication as:

Bennetts, R., S. Corn, R. Daley, W. R. Gould, C. Jean, D. A. Patla, C. R. Peterson, and A. Ray. 2013. Cooperative amphibian monitoring protocol for the Greater Yellowstone Network: Standard operating procedures, version 1.0. Natural Resource Report NPS/GRYN/NRR—2013/655. National Park Service, Fort Collins, Colorado.

NPS 960/120502, April 2013

Contents

Contents (continued)

Page

Contents (continued)

Contents (continued)

Figures

Figures (continued)

Page

Tables

Page

Standard Operating Procedure (SOP) 1:
Field Safety for the Amphibian Monitoring Program

Version 1.0, April 2013

Change History

Original Version #	Date of Revision	Revised By	Changes	Justification	Pages Affected	New Version #

Required Reading

Driving Safety Job Hazard Analysis V2.0
http://imnetsharepoint/gryn/Safety/GRYN_JHA_Driving_Safety_V2.0.docx.

Greater Yellowstone Network (GRYN). 2012. Safety Plan for the Greater Yellowstone Inventory and Monitoring Network V2.0. National Park Service, Greater Yellowstone Network, Bozeman, MT http://imnetsharepoint/gryn/Safety/GRYN_SafetyPlan_V2.0_signed.docx.

Vegetation Monitoring Job Hazard Analysis V2.0
http://imnetsharepoint/gryn/Safety/GRYN_JHA_Vegetation_Monitoring_V2.0.docx.

Overview

A primary goal of the Greater Yellowstone Network (GRYN) is to ensure the safety of its staff and partners while conducting inventory and monitoring activities in parks. The safety plan for the GRYN (GRYN 2012) is the foundation document for conducting safe field work and includes both action plans and reference materials for NPS personnel and partners. Encountering hazardous situations is inherent in outdoor monitoring activities, and all staff persons need to be aware of the risks and take adequate precautions.

Risks Inherent in Amphibian Monitoring

1. A Job Hazard Analysis (JHA) has been completed for the GRYN Amphibian Monitoring Program at Grand Teton (GRTE) and Yellowstone (YELL) National Parks and the John D. Rockefeller Jr. Memorial Parkway (JODR) following procedures in the NPS Reference Manual #50B, Occupational Safety and Health Program (NPS 2008). The JHA identifies potential hazards for each task, and procedures on how to reduce or abate the hazard. This JHA and the Driving Safely JHA are fundamental to safe field operations. See Table 1-1 for the list of topics addressed by the amphibian monitoring protocol JHA.

2. Wetland and amphibian breeding habitats in GRTE and YELL and the JODR (together considered the Greater Yellowstone Ecosystem or GYE) can be in remote and rugged areas. Wildlife sightings or confrontations, river crossings, steep slopes, and hummocky and uneven terrain are routinely encountered when traveling to and from sampling catchments and between survey sites within a catchment. Field work in the GYE can also bring with it challenging weather extremes; cold rainy weather, and even snow, can be encountered in July, and extremely hot weather encountered throughout the survey season. More commonly, a combination of heat (air temperatures exceeding 80°F), humidity, and the presence of mosquitos and other biting insects are experienced throughout the survey period. In addition, long days in the field followed by camping outdoors at night further increases exposure to ticks, mosquitoes, mice (all may carry zoonotic diseases), and to large and potentially dangerous wildlife (e.g., grizzly and black bears). Other risks, described in the JHA include working in pairs or small groups in rugged and isolated environments, long driving trips between parks and network offices, extreme weather, and hazardous fire conditions.

Procedures

1. A safety orientation program will be provided to each new and returning employee to learn about procedures that safeguard each person in the performance of their assigned tasks.

2. Each year the Amphibian Monitoring JHA and Driving Safety Job Hazard Analysis will be reviewed and updated if necessary. All crew members must review the Job Hazard Analysis during staff training. The JHA follows procedures in the NPS Reference Manual #50B, Occupational Safety and Health Program (NPS 2008). The JHA identifies potential hazards for each task, and procedures on how to reduce or abate the hazard. See Table 1-1 for the list of topics addressed by the amphibian monitoring protocol JHA.

3. Tailgate safety sessions will be held before each field hitch to regularly communicate safety and any emerging concerns, such as inclement weather, road conditions, and fire hazards.

4. Specific park hazards, emergency contact information, and procedures should be reviewed with park staff at the start of each park sampling session. Park safety protocols must be reviewed and adhered to.

5. Each crew will be provided a personal locating beacon (PLB), a radio, and cellular or satellite phone depending on the location and signal availability. Crews are required to check in with park dispatch or park resource personnel upon arrival in the park and when they leave at the end of the hitch.

6. Daily check-ins with the GRYN staff take place morning and night (at specified times) using the PLB and when cell phone coverage is available, crews check-in by phone to obtain any needed situational updates and to affirm that travel continues as planned. Having established lines of communication and a Check-in/Check-out procedure are essential to ensure timely assistance can be provided in case of a mishap or delay. These procedures are described in the GRYN Safety Plan (2012).

7. The team must check-in with park points of contact (e.g., research coordinator, resource staff, or dispatch) periodically during park sampling season to keep abreast of developing safety information, and to provide park staff with locations of operation. Cellular phones can be used depending on signal availability.

8. The minimum crew size is two people; working alone in the field is NOT permitted. Only during dual surveys, do crews have permission to split up and work independently at the same site. During this time, crew members must pay particular attention to safety communication; members must remain within earshot of one another so they can alert one another of approaching wildlife or other hazards or potential dangers.

9. Field technicians will work in teams of two, and each team will be provided a two-way radio and PLB.

10. Each team member must know where vehicle keys are to be stored during field operations, the location of the nearest pay phone and cellular phone signal availability, and emergency contact and operation procedures for each park.

11. Agency driving regulations must be followed. Field crews will depart the office (or the field) with plenty of time left in the workday to arrive without exceeding the 10-hour work day limit unless prior approval by the program manager and a GAR (Green Amber Red) has been completed.

12. The recommended footwear for traversing rugged and steep terrain is a hiking boot, 6-8” in height, with slip-resistant heels and soles with firm, flexible support to help reduce chances of slips, trips, and falls. Recommended clothing in the field is long-sleeved shirts and long pants to guard from brush, insect and snake bites. Waders are recommended for walking in wetlands and beaver ponds for extended periods. Wide-brimmed hats are recommended to protect from sun exposure, along with sunscreen. Mosquito head nets are recommended. Although temperatures can be warm, precautionary clothing will help reduce risks such as sun exposure, cuts, and scratches from environmental exposure while conducting field work.

13. Pepper spray (e.g., bear deterrent) is required to be carried by all crew members at all times. Bear deterrent spray should be holstered in sleeves provided by the manufacturer and worn on belts or backpack belt straps in a location that is comfortable and prevents accidental discharge. When not in the field or during transport, bear-deterrent spray must be contained in a tight container equipped with absorbing foam. Approved containers are provided to all crew members by the GRYN safety manager. Additional details about storage and transport are provided in the GRYN Safety Plan (2012).

Table 1-1. Topics addressed in the Amphibian Monitoring and Driving Safety JHAs.

General Job Activity	Basic Job Step	Potential Hazards
Communication	Two daily check-ins with GRYN field coordinator or designee	PLB does not work; cannot make verbal contact with coordinator (Search and Rescue initiated when not needed if crews forget to check-in two times in a row)
	Communication with work partner when working without radio contact	Loss of contact with field partner(s)/team member(s) Unable to reach a radio repeater in a remote location
All Field Activities	Hiking	Steep, rugged and slippery terrain Undergrowth Rocks/climbing Bad footwear lead to sprains/twists to knees and ankles; blisters to feet Backstrain from backpack Muscle Soreness Dehydration Sunburn
	Encountering noxious plants, animals, disease, and people	Bees/wasps, hornets Ticks Mosquitoes Rattlesnakes Mountain lions Bears (black and grizzly) Disease (bubonic plague and Hanta virus) Poison ivy/stinging nettles Encounters with strangers
	Crossing flowing water	Slipping Hypothermia Drowning
	Surveying in wetlands and beaver ponds	Slipping/Falling Getting hit by overhanging or woody vegetation Drowning Getting mired in soft substrates
	Exposure to environment	Hypothermia Hyperthermia Giardia caused by drinking water Sunburn
Accessing Sites	Highway driving	Varied road conditions Fatigue Behavior of other drivers Animals and other obstructions Driving through the parks can be tedious with visitors stopping
	Driving on unimproved roads	Rough and vegetated roads Muddy roads Fire ignition during dry weather Narrow roads with poor visibility
	Hiking	Steep, rugged, and slippery terrain Undergrowth Rocks/climbing Bad footwear may lead to sprains/twists to knees and ankles; blisters to feet Backstrain from backpack Muscle soreness Dehydration Sunburn

Safety Cautions

While an effort has been made to reduce exposure to unsafe terrain, it is incumbent upon field personnel to make conservative decisions and choose the safest routes possible to access sampling areas. This may require longer travel times in order to circumvent risky terrain or to avoid disturbing wildlife (e.g., bison) and may ultimately reduce the number of sites surveyed in a given day. Safety is more important than productivity, and the GRYN does not want the drive or hike to complete surveys to cloud good judgment. In other words, stay alert and take it easy out there! Of the several safety procedures described in the GRYN safety plan, some are more relevant to this project and described in the various safety documents. Ultimately, it is up to each individual to be in charge of their own safety.

References

Greater Yellowstone Network (GRYN). 2012. Safety Plan for the Greater Yellowstone Inventory and Monitoring Network V2.0. National Park Service, Greater Yellowstone Network, Bozeman, MT http://imnetsharepoint/gryn/Safety/GRYN_SafetyPlan_V2.0_signed.docx.

National Park Service (NPS). 2008. Occupational Safety and Health Program. NPS Director's Order #50B. Located at: http://www.nps.gov/applications/npspolicy/DOrders.cfm

Standard Operating Procedure (SOP) 2: Pre-season Preparations and Equipment Setup

Version 1.0, April 2013

Change History

Original Version #	Date of Revision	Revised By	Changes	Justification	Pages Affected	New Version #

Overview

This SOP describes the step-by-step procedures needed for the preparation and successful completion of field work associated with GRYN's amphibian monitoring program. These procedures include coordinating with park personnel and securing all necessary permits. In addition, this SOP outlines equipment needs, navigation and data collection requirements, and post-field work necessities. Scheduling details are also provided because preparation and scheduling are crucial to the successful execution and completion of field work during the amphibian monitoring season.

Pre-Season Tasks

January-February

- File the Investigators Annual Report (IAR) for the previous field season in YELL and GRTE as instructed by the research permit offices.
- File research permit renewal application and other paperwork required by YELL and GRTE.
- File annual report and scientific permit request with Wyoming Game & Fish Department.
- Advertise field crew positions through national web sites and regional universities.

March-April

- Draft the field schedule to accomplish the catchment surveys, using guidelines for timing and respecting management closures and restrictions.
- Reserve backcountry campsites based on the draft field schedule for the season. Request permission to camp at undesignated sites, where necessary.
- Clarify with the research permit office if any new restrictions apply since the previous year, and if catchments may be visited as planned.
- Request boat transport across Yellowstone and Jackson lakes or use of backcountry patrol cabins for the remote catchments, if needed.
- Sign and mail research permit to parks; confirm this is done.
- Screen and interview field crew candidates, check references, extend job offers.
- Arrange for any other field assistance, including ARMI crews from other areas for the catchment surveys and volunteers for the boreal toad project.
- Inspect and procure equipment.
- Inventory and order supplies.
- Set up and test field computers with field forms, in coordination with GRYN data manager and ARMI personnel. Ensure that database is linked correctly with electronic data collection forms.
- Confirm and select survey sites for the current year.
- Prepare site navigation and identification aids for each catchment (see following section) and assemble in folders for each catchment.

May-early June

- Provide names of seasonal field crew to research permit offices.
- Mail maps and instructions to field crews.
- Complete work on catchment folders (maps and navigation aids).
- Prepare field crew training materials.
- Assemble supplies and equipment and make sure all are ready and in proper functioning order.
- Pick up research permits from parks.
- Visit field crew training sites in YELL to see if conditions are suitable for training.
- Perform final tests of electronic devices (e.g., GPS units and field computers).
- Set up the operations base for the field season (bring equipment and supplies; store these items securely).

Confirming and Selecting Survey Sites for the Current Year

This process ensures that the sites identified for upcoming surveys reflect the latest sample frame identifiers and selected catchments, including any adjustments to the catchments currently selected and scheduled for sampling, and omits any specific sites that the protocol leader determines are not potential breeding sites based on an assessment of available information and database content. The target site list resulting from this process is used to create field maps, prepare hardcopy site lists, and upload waypoints to GPS units.

The project data manager or other personnel familiar with relational database objects, object relationships, and advanced queries in Microsoft Access can help accomplish this using a variety of approaches. One pathway is offered here.

First, in the master database for the project, open the table named “z-Sample_Frame_Strata” and make sure it exactly matches the ‘Master List’ in the Microsoft Excel file named “GRTE_YELL_Amphibian_Monitoring_SampleFrame_and_Selection_MASTER.xls” located on the GRYN server here:
U:\Monitoring\Active_Vital_Signs\Amphibians\Sampling_Design\Master_Files\

After table “z-Sample_Frame_Strata” is reviewed and updated if necessary, create a series of queries against the tables in the master database to generate an initial list of sites to visit in the upcoming field season. The queries should be stored in a separate Microsoft Access file that links to the tables in the master database. It may be necessary to relink the tables each time the master data file is updated (usually following quality assurance activities in the fall of each year). The following individual queries are based on the structure of database tables through 2012. Each query results in a part of the final result assembled using the last query in this series (qry_CandidateSites_forUpcomingSurveys). As of April, 2013 these queries are stored in this location on the GRYN server:
U:\Monitoring\Active_Vital_Signs\Amphibians\Data\GRYN_Interface_to_ARMI_DB\GRTE_YELL_ARMI_DB_GRYNuserInterface.mdb

Create or use the select query named ‘qry_MostRecentSurvey_bySite’:

```
SELECT WetlandsSurvey.LocationID, Max(WetlandsSurvey.Date) AS MaxOfDate,
WetlandsSurvey.SurveyConducted
FROM WetlandsSurvey
GROUP BY WetlandsSurvey.LocationID, WetlandsSurvey.SurveyConducted
HAVING (((WetlandsSurvey.SurveyConducted)="Yes"))
ORDER BY WetlandsSurvey.LocationID;
```

Create or use the select query named ‘qry_MostRecentPotentiallySurveyable_bySite’:

```
SELECT WetlandsSurvey.LocationID, Max(WetlandsSurvey.Date) AS MaxOfDate,
WetlandsSurvey.SurveyConducted, WetlandsSurvey.PotentiallySurveyableAnyYear
FROM WetlandsSurvey
GROUP BY WetlandsSurvey.LocationID, WetlandsSurvey.SurveyConducted,
WetlandsSurvey.PotentiallySurveyableAnyYear
HAVING (((WetlandsSurvey.SurveyConducted)="No") AND
((WetlandsSurvey.PotentiallySurveyableAnyYear)="Yes"))
ORDER BY WetlandsSurvey.LocationID;
```

Create or use the crosstab query named ‘qry_xtab_SitesSurveyed_byYear’:

```
TRANSFORM First(WetlandsSurvey.SurveyConducted) AS FirstOfSurveyConducted
SELECT WetlandsSurvey.PrimarySecondary, WetlandsSurvey.Catchment, WetlandsSurvey.LocationID
FROM WetlandsSurvey
WHERE (((WetlandsSurvey.PrimarySecondary)="Primary"))
GROUP BY WetlandsSurvey.PrimarySecondary, WetlandsSurvey.Catchment,
WetlandsSurvey.LocationID
ORDER BY WetlandsSurvey.LocationID
PIVOT Year([Date]);
```

Create or use the crosstab query named ‘qry_xtab_SitesPotentiallySurveyable_byYear’:

```
TRANSFORM First(WetlandsSurvey.PotentiallySurveyableAnyYear) AS
FirstOfPotentiallySurveyableAnyYear
SELECT WetlandsSurvey.PrimarySecondary, WetlandsSurvey.Catchment, WetlandsSurvey.LocationID
FROM WetlandsSurvey
WHERE (((WetlandsSurvey.PrimarySecondary)="Primary"))
GROUP BY WetlandsSurvey.PrimarySecondary, WetlandsSurvey.Catchment,
WetlandsSurvey.LocationID
ORDER BY WetlandsSurvey.LocationID
PIVOT Year([Date]);
```

Create or use the select query named ‘qry_MostRecentHabitatDate_byLocationID’

```
SELECT Max(Habitat.TimeOfRecord) AS MaxOfTimeOfRecord, Habitat.LocationID
FROM Habitat
GROUP BY Habitat.LocationID;
```

Create or use the select query named ‘qry_MostRecentHabitatValues_bySite’:

```
SELECT Habitat.LocationID, Habitat.HabitatType, Habitat.MaxDepth, Habitat.Length, Habitat.Width,
Habitat.DiscreteWaterBodies
FROM qry_MostRecentHabitatDate_byLocationID INNER JOIN Habitat ON
(qry_MostRecentHabitatDate_byLocationID.LocationID = Habitat.LocationID) AND
(qry_MostRecentHabitatDate_byLocationID.MaxOfTimeOfRecord = Habitat.TimeOfRecord);
```

Create or use the select query named ‘qry_MostRecentSurveyDate_byLocationID’:

```
SELECT WetlandsSurvey.LocationID, Max(WetlandsSurvey.Date) AS MaxOfDate,
WetlandsSurvey.SurveyConducted
FROM WetlandsSurvey
GROUP BY WetlandsSurvey.LocationID, WetlandsSurvey.SurveyConducted
HAVING (((WetlandsSurvey.SurveyConducted)="Yes"));
```

Create or use the select query named ‘qry_MostRecentSearchTime_bySite’:

```
SELECT WetlandsSurvey.LocationID, WetlandsSurvey.SearchTime, WetlandsSurvey.PrimarySecondary
FROM qry_MostRecentSurveyDate_byLocationID INNER JOIN WetlandsSurvey ON
(qry_MostRecentSurveyDate_byLocationID.LocationID = WetlandsSurvey.LocationID) AND
(qry_MostRecentSurveyDate_byLocationID.MaxOfDate = WetlandsSurvey.Date)
WHERE (((WetlandsSurvey.PrimarySecondary)="Primary"))
ORDER BY WetlandsSurvey.LocationID;
```

Now, create or use the select query named ‘qry_CandidateSites_forUpcomingSurveys’ to link the results of the above queries together, along with a filter for sites in catchments selected for monitoring according to table “z-Sample_Frame_Strata”. The result of this query lists candidate sites with all the fields required to support mapping, GPS use, and hardcopy site lists:

```
SELECT qry_xtab_SitesSurveyed_byYear.Catchment, qry_xtab_SitesSurveyed_byYear.LocationID,
qry_xtab_SitesSurveyed_byYear.[2005] AS Surveyed2005, qry_xtab_SitesSurveyed_byYear.[2006] AS
Surveyed2006, qry_xtab_SitesSurveyed_byYear.[2007] AS Surveyed2007,
qry_xtab_SitesSurveyed_byYear.[2008] AS Surveyed2008, qry_xtab_SitesSurveyed_byYear.[2009] AS
Surveyed2009, qry_xtab_SitesSurveyed_byYear.[2010] AS Surveyed2010,
qry_xtab_SitesSurveyed_byYear.[2011] AS Surveyed2011, qry_xtab_SitesSurveyed_byYear.[2012] AS
Surveyed2012, qry_xtab_SitesPotentiallySurveyable_byYear.[2005] AS Surveyable2005,
qry_xtab_SitesPotentiallySurveyable_byYear.[2006] AS Surveyable2006,
qry_xtab_SitesPotentiallySurveyable_byYear.[2007] AS Surveyable2007,
qry_xtab_SitesPotentiallySurveyable_byYear.[2008] AS Surveyable2008,
qry_xtab_SitesPotentiallySurveyable_byYear.[2009] AS Surveyable2009,
qry_xtab_SitesPotentiallySurveyable_byYear.[2010] AS Surveyable2010,
qry_xtab_SitesPotentiallySurveyable_byYear.[2011] AS Surveyable2011,
qry_xtab_SitesPotentiallySurveyable_byYear.[2012] AS Surveyable2012, [z-
Sample_Frame_Strata].Selection_Status, Sites.UTMEasting, Sites.UTMNorthing, Sites.UTMZone,
"NAD27" AS Datum, Sites.EPEMeters, qry_MostRecentSurvey_bySite.MaxOfDate AS
MostRecentSurvey, qry_MostRecentPotentiallySurveyable_bySite.MaxOfDate AS
MostRecentPotentiallySurveyable, qry_MostRecentHabitatValues_bySite.HabitatType,
qry_MostRecentHabitatValues_bySite.MaxDepth, qry_MostRecentHabitatValues_bySite.Length,
qry_MostRecentHabitatValues_bySite.Width, qry_MostRecentHabitatValues_bySite.DiscreteWaterBodies,
qry_MostRecentSearchTime_bySite.SearchTime AS MostRecentSearchTime

FROM (((((([z-Sample_Frame_Strata] INNER JOIN (qry_xtab_SitesPotentiallySurveyable_byYear INNER
JOIN qry_xtab_SitesSurveyed_byYear ON qry_xtab_SitesPotentiallySurveyable_byYear.LocationID =
qry_xtab_SitesSurveyed_byYear.LocationID) ON [z-Sample_Frame_Strata].CatchTxt =
qry_xtab_SitesSurveyed_byYear.Catchment) INNER JOIN Sites ON
qry_xtab_SitesPotentiallySurveyable_byYear.LocationID = Sites.LocationID) LEFT JOIN
qry_MostRecentSurvey_bySite ON Sites.LocationID = qry_MostRecentSurvey_bySite.LocationID) LEFT
JOIN qry_MostRecentPotentiallySurveyable_bySite ON Sites.LocationID =
qry_MostRecentPotentiallySurveyable_bySite.LocationID) LEFT JOIN
qry_MostRecentHabitatValues_bySite ON Sites.LocationID =
qry_MostRecentHabitatValues_bySite.LocationID) LEFT JOIN qry_MostRecentSearchTime_bySite ON
Sites.LocationID = qry_MostRecentSearchTime_bySite.LocationID

WHERE ((([z-Sample_Frame_Strata].Selection_Status) Like "*selected*"));
```

Export the query result to Microsoft Excel in this folder on the GRYN server: \\Monitoring\Active_Vital_Signs\Amphibians\Projects\GRTE_YELL_LTM_Amphibians\2013\Field_Prep\ with a file name like GRTE_YELL_2013_Amphibian_Monitoring_CandidateSites.xlsx. (Change the year to reflect the upcoming survey year.)

Make a copy of the Excel file and name it GRTE_YELL_2013_Amphibian_Monitoring_TargetSites.xlsx. The protocol lead reviews the ‘target sites’ file and delete rows for sites that surveyors don’t need to visit due to previously recorded conditions that reflect a lack of suitable habitat. Additional investigation of field notes and database comments may be necessary to make these decisions.

Creating Field Maps

Add the table of target survey sites from the previous section as an XY layer in ArcMap. Add a topographic base map and layers for catchment boundaries, labeled site locations, and National Wetland Inventory (NWI) polygons (see Figure 2-1 for an example). Construct a map layout using a scale factor of 1:24000. Print the required number of copies for each catchment folder.

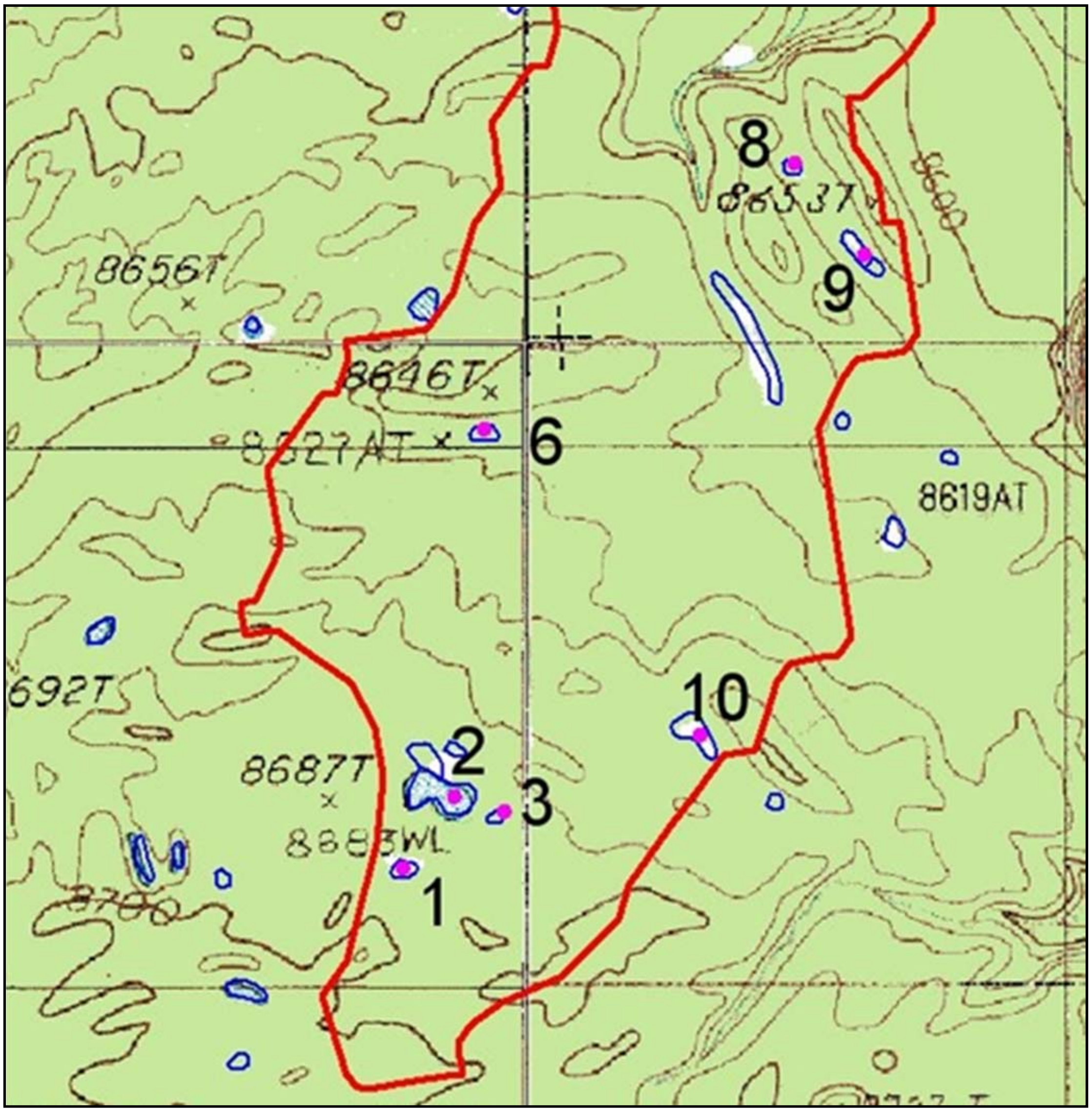


Figure 2-1. Map showing catchment boundaries (red lines), site locations (pink dots), site ID numbers (black numbers), and NWI polygons (blue lines).

Uploading Sites as Waypoints to GPS Units

In Microsoft Excel create a copy of the worksheet containing the target sites and name the copy 'formatted for GPS.' Adjust and format the new worksheet for input into DNR GPS version 6 by carefully matching the column names and cell value formats shown in this image:

(Note – the project is transitioning from NAD27 to NAD83 coordinates, so the comment values shown in this example specify the datum for the 2013 operating period, and this will change when the transition to NAD83 is complete.)

	A	B	C	D	E	F	G
1	type	ident	lat	long	y_proj	x_proj	comment
2	WAYPOINT	GRTE_3496_1			4876496	513447	NAD27 UTM12
3	WAYPOINT	GRTE_3496_2			4876519	513390	NAD27 UTM12
4	WAYPOINT	GRTE_3496_3			4876640	513266	NAD27 UTM12
5	WAYPOINT	GRTE_3496_4			4876605	513232	NAD27 UTM12
6	WAYPOINT	GRTE_3496_5			4876686	513133	NAD27 UTM12
7	WAYPOINT	GRTE_3496_6			4876760	513127	NAD27 UTM12
8	WAYPOINT	GRTE_3496_7			4876848	513017	NAD27 UTM12
9	WAYPOINT	GRTE_3496_8			4876862	513158	NAD27 UTM12
10	WAYPOINT	GRTE_3496_9			4876629	513023	NAD27 UTM12
11	WAYPOINT	GRTE_3504_1			4876102	525400	NAD27 UTM12

Select Save As from Excel's File menu.

Save the file as Type = CSV (Comma delimited) (*.csv) with file name = GRTE_YELL_<current_YEAR>_Amphibian_MonitoringPoints_forGPS.csv to folder: ::\Monitoring\Active_Vital_Signs\Amphibians\Projects\GRTE_YELL_LTM\<YEAR>\Field_Prep\

In Windows Explorer change the extension of the file from .csv to .txt.

In DNR GPS:

DNR GPS, released in 2012 by the Minnesota Department of Natural Resources, is an Open Source update to the popular DNR Garmin application. It provides users the ability to transfer data between handheld GPS receivers and GIS software.

Select Set Projection from the File menu, choose the correct datum and projection (normally UTM Zone 12N), and click Ok.

Open File → Load From → File

Change the File Type filter to Text file (comma delimited).

Navigate to the folder holding the new text file of GPS waypoints.

Load the file.

Review the results of the loaded values. Make sure all records are present compared to the total number of target sample points in Excel and in the sample point feature class in the master Geodatabase. Before proceeding, make any necessary adjustment or corrections, including reformatting the source file and reloading if necessary.

From the Edit menu select Unproject Coordinates. This populates the *lat* and *long* columns, which is required in order to save the waypoints in GPX format.

Open File → Save To → File

Set Save as Type to GPS Exchange Format (*.gpx)

Set the file name to GRTE_YELL_<current_YEAR>_Amphibian_MonitoringPoints_forGPS.gpx.

Save the file to the current year's Field-Prep folder.

When prompted, select Waypoints as the GPS type.

In Garmin BaseCamp:

From the File menu select Import into my collection.

Locate and load the GPX file saved from DNR GPS in the previous step.

For each sample frame, select all panel one waypoints from the list and set the symbol color to Green. The default flag symbol for waypoints is normally a good choice, but can be changed if another symbol is preferred.

Select all remaining waypoints (representing over-sample points) and set the symbol color to Red. This helps differentiate panel one and over-sample points on the GPS screen while navigating in the field.

Connect a GPS device to the computer.

Check for existing data on the connected GPS device.

If data still exists on the device, then contact the previous user(s) of the device to determine if the data are already transferred and saved. If in doubt, or the previous user isn't available, go ahead and transfer the data to Garmin BaseCamp from the device and export the transferred data to this folder on the GRYN server in GPX format:

::\General_Library\GPS_Data_Unclaimed\

After reviewing and saving what is needed, remove all waypoint, track, image, and other data from the GPS unit.

Send the current year waypoints to the device. If the device has limited memory and only some of the waypoints fit in memory, then select and send only the waypoints required for the upcoming field trip.

Select the device from the list in Garmin BaseCamp Library and view the loaded waypoints to confirm the device contains what you need. Make any required adjustments.

Disconnect the device and close Garmin BaseCamp.

On the GPS device:

After disconnecting the device, and before leaving the computer for the field trip, turn on the GPS unit and open the list of loaded waypoints to confirm the required waypoints are loaded, correctly symbolized, named, and commented for use in the field. (For assistance refer to the device's operating manual and consult program staff.)

Make any necessary adjustment and then turn off the GPS unit.

Uploading Catchment Boundaries as Tracks to GPS Units

In ArcMap:
From the master sample frame Geodatabase, select the catchment features where upcoming surveys will occur. Export the selected features to a shapefile with a name like: 'CatchmentBoundaries2013_forGPSUpload' in a location like U:\Monitoring\Active_Vital_Signs\Amphibians\Projects\GRTE_YELL_LTM_Amphibians\2013\Field_Prep\

In DNR GPS:

Select Set Projection from the File menu, choose the correct datum and projection (normally UTM Zone 12N), and click Ok.

Open File → Load From → File

Change the File Type filter to Shapefile.

Navigate to the folder holding the shapefile containing catchment boundaries.

Select and open the shapefile.

When prompted select 'CATCH_ID' for the identification field.

Review the results and make any necessary adjustment or corrections, including reformatting the source file and reloading if necessary.

Open File → Save To → File

Set Save as Type to GPS Exchange Format (*.gpx)

Set the file name to
GRTE_YELL_<current_YEAR>_Amphibian_CatchmentTracks_forGPS.gpx.

Save the file to the current year's Field-Prep folder.

When prompted, select Tracks as the GPS type.

In Garmin BaseCamp:

From the File menu select Import into my collection.

Locate and load the GPX file saved from DNR GPS in the previous step.

Set the symbol color as desired.

Connect a GPS device to the computer.

Check for existing data on the connected GPS device.

If data still exist on the device, then contact the previous user(s) of the device to determine if the data are already transferred and saved. If in doubt, or the previous user isn't available, go ahead and transfer the data to Garmin BaseCamp from the device and export the transferred data to this folder on the GRYN server in GPX format:
::\General_Library\GPS_Data_Unclaimed\

After reviewing and saving what is needed, remove all waypoint, track, image, and other data from the GPS unit.

Send the required tracks to the device. If the device has limited memory and only some of the tracks fit in memory, then select and send only the tracks required for the upcoming field trip(s).

Select the device from the list in Garmin BaseCamp Library and view the loaded tracks to confirm the device contains what you need. Make any required adjustments.

Disconnect the device and close Garmin BaseCamp.

On the GPS device:

After disconnecting the device, and before leaving the computer for the field trip, turn on the GPS unit and open the list of loaded tracks to confirm the required tracks are loaded, correctly symbolized, named, and commented for use in the field. (For assistance refer to the device's operating manual and consult program staff.)

Make any necessary adjustment and then turn off the GPS unit.

Creating a List of Sites in Each Catchment

In Microsoft Excel create a copy of the worksheet containing the target sites and name the copy 'formatted for printed list'. Format the list generally following the example in Table 2-1, and set the page layout to print on the desired paper size, etc. Include site names ('LocationID' from the database), the GPS waypoint name, location coordinates for a point near the center of the sites, date of previous survey (or when site was identified as a potential site), whether or not the site was surveyed the previous year, search time (primary survey, from the previous year's survey), habitat type recorded at previous survey, max depth, length and width of water bodies, and the number of discrete water bodies previously found within the site during the most recent survey (see Table 2-1 for an example).

Table 2-1. Site information provided to field crews for catchments previously visited.

LocationID	GPS	Easting	Northing	Date	Surveyed in 2006	Time	Habitat	Max Depth	Length	Width	Water Bodies
YELL_3427_2	3427x1	525538	4886690	6/21/2006	Yes	26	lake/pond/pool	<1	55	30	1
YELL_3427_5	3427x5	525514	4886441	6/22/2006	Yes	81	lake/pond/pool	>2	1000	500	1
YELL_3427_6	3427x6	525366	4886882	7/26/2005	No						
YELL_3427_8	3427x8	525513	4886898	6/21/2006	Yes	10	lake/pond/pool	<1	12	7	1
YELL_3427_10	342710	525383	4886998	6/21/2006	Yes	16	lake/pond/pool	<1	15	12	1
YELL_3427_12	342712	525487	4887034	6/21/2006	Yes	5	lake/pond/pool	<1	3	3	1

Prepare Photo Sheets for Each Site

Create a Report in Microsoft Access that includes Location ID, Date (time of record), Camera, Frame, Bearing, Easting and Northing and estimated position error (EPE) of photo point. Export this report in rtf format. Open the rtf file in Microsoft Word and save as a doc or docx file. Copy the block of text for each photo point to be used and paste it into Microsoft Word. Import the photo for this photo point and place it next to the block of text. [Note: To prepare the photos, use an image viewer/editor program to view photos and copy the required photos to a new folder. Batch processing can be used if necessary to resize or adjust the image collection. Image file size should be 100kb – 300kb. Use a consistent convention for naming images, such as <Park code> _<site code>_ <image number> _<description>; e.g, '*Y3276-3_pic4423_26Jun05'*. Create a photo document like the example in Figure 2-2 for each catchment to print for field use.

LOCATION_ID YELL_3427_61

DATE 6/21/2006

Camera 3 **Frame** 285

BEARING 130

Easting 525031

Northing 4886544 **EPE** 9

DATUM: NAD27

Figure 2-2. Site photos from previous year, provided to field crew to assist in identifying sites and re-taking photos.

Prepare Site Drawings for Each Site

Scan previous site drawings and print out for use in the field. These site maps roughly show the shape, size, vegetative features, and orientation of the site, along with photo point and site location (see Figure 2-3 for an example).

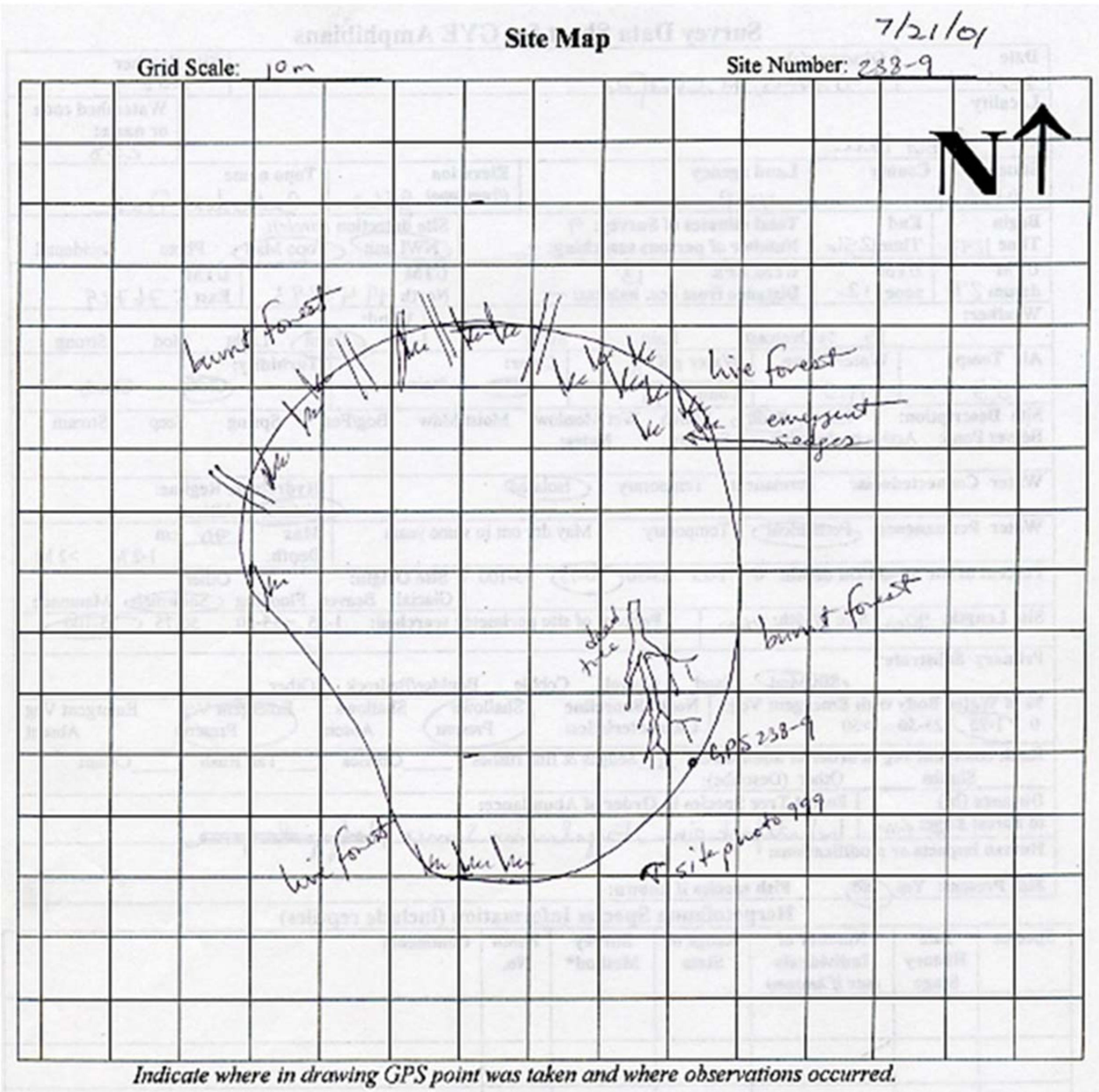


Figure 2-3. Drawing of site showing approximate size and shape, provided to field crews to assist in identifying sites and retaking photos.

Equipment and Supplies List

Each two-person field crew will be equipped with the following:

- Handheld or tablet field computer with accessories: back-up media, spare battery, waterproof case. The computers are programmed with data forms that link to a relational database when downloaded. The forms and database are designed and provided by USGS-ARMI, and modified as needed by the GRYN data manager and NRCC field coordinator.

- GPS, with accessories: batteries, battery charger, cable for connecting to computer. Survey targets and catchment boundaries must be pre-loaded into the GPS units prior to surveys.

- Camera, digital, with accessories: batteries, charger, storage media, reader or cable to download photos.

- Communications radio, with accessories: spare batteries, charger, and case or holsters. These radios are borrowed from GRYN and are programmed for use on YELL and GRTE frequencies. Training on use is provided by YELL staff.

- Waders, one pair per person. Light-weight, sturdy, and amenable to thorough cleaning and disinfection, these are purchased prior to each field season.

- Nets, one per person. Long-handled and fine mesh.

- Conductivity and pH meter, and calibration fluids, if required. Thermometer, armored, for air and water.

- Compass, for navigation and site photo bearings.

- Field book, rite-in-the-rain, one per person. For recording data to be transferred to field forms or electronic device, making other notes, etc.

- Clipboard or map case or binder to carry forms and maps.

- Validation photo supplies (for photos of larvae): erasable photo card, 2 wet-erase pens, 2 petri dishes.

- Collection kit (if authorized by NPS to collect dead or dying specimens): latex gloves, containers and whirlpacks, baggies, 70% ethanol, labels, permanent ink pen, razor blade.

- Pepper/bear spray, one per person.

- Vehicle (one per field crew). Nearly all driving is on paved park roads; sedans (rather than trucks) are suitable and preferred due to their better fuel efficiency and lower operation costs.

- First aid kit, one per person. First aid kits should be equipped with materials approved by GRYN's safety officer.

- Polarized sunglasses.

- Employees are expected to bring their own outdoor gear including backpack, tent, sleeping bag, water filter, cookstove, hiking boots, clothing and rainwear.

Project equipment for use by all crews:

- Laptop computer. For downloading data from handheld electronic devices, storing photos, and getting GPS data for targeted survey sites.

- Sanitization gear. Basin for washing/disinfecting waders and nets; disinfectant; brushes and rubber gloves.

Standard Operating Procedure (SOP) 3: Daily Procedures and Checklists

Version 1.0, April 2013

Change History

Original Version #	Date of Revision	Revised By	Changes	Justification	Pages Affected	New Version #

Overview

This SOP provides an equipment checklist that should be reviewed each morning and prior to setting off into the field on a day or multi-day backpacking trip. Also included are post-trip (day trip) and daily (multi-day backpacking trip) data back-up and equipment cleaning/sanitizing procedures. Again, the checklist and all procedures in this SOP should be reviewed each day.

Procedures

We are frequently able to use park cabins, dormitories, and other facilities to implement the fieldwork. Please be respectful of all NPS and NPS partner facilities and make sure facilities are clean and secure prior to your leaving. This is essential to our continued use of NPS accommodations. In most cases, if you have any issues with any of the facilities that we use, please bring this forward to the field coordinator as early as possible; it is often best to have him/her address the problem.

Morning

Before leaving for the field, make sure you understand directionally, how to reach the assigned catchment, have any special instructions for the area, and have the following items:

<u>Survey gear (per person)</u>

- Waders
- Nets

<u>Electronic equipment (per crew)</u>

- GPS (loaded with sample site features/coordinates) and spare batteries
- Hand-held data collection device (tablet or hand-held computer), back-up memory card, and spare battery
- Digital camera and spare batteries

<u>Data collection gear (per crew)</u>

- Clipboard or map case, with study area maps and target list for the catchment
- Field forms
- Field book (e.g., rite-in-the-rain)
- Pen, pencil, and eraser
- Photo card and wet-erase pens
- Photo voucher cups
- pH and conductivity meters (if using)
- Thermometer
- Compass
- Collecting kit (if authorized by NPS to collect dead or dying specimens) for dead amphibians (a small re-sealable plastic container including baggies and whirlpacks, 70% ethanol, razor blade, label tape, and permanent marker)

<u>Safety and well-being</u>

- Park communications radio (1 per crew)
- PLB (1 per crew)
- Bear-deterrent/pepper spray
- Water and food
- Rain gear and warm clothes in case of storm
- Hand sanitizer
- First aid kit

<u>Research permit</u> (always have a copy with at least 1 crew member in the field)

End of Day or Backpack Trip

1. Synchronize field computer to laptop computer (use ADMIN, password=ARMI). Data will be automatically stored in a Microsoft Access database: C:\ARMI\RockyMountainsARMI.mdb.

   Data will be retained on the field computer for 5 or 10 days. If problems are encountered or error messages appear during synchronization attempt, write a description of the problem in the Data Logbook, and notify the project coordinator as soon as possible.

2. To check if your data is recorded and complete, run the series of CHECK queries that are provided within the database and review the results of each.

   CHECK-Surveys. Filter by catchment and verify that all sites you surveyed are listed. If Survey Conducted=Yes, make sure that both Primary and Secondary surveys are listed.

   CHECK-Weather by Survey. Filter by catchment and verify that all fields are filled in for the sites you surveyed, and that fields have the correct information.

   CHECK-Habitat per Survey. Filter by catchment and verify that all fields are filled in and have the correct information.

   CHECK- Species Found. Filter by catchment and verify that each site you surveyed has the species, life stages, and numbers that were detected for both primary and secondary surveys.

   If there are discrepancies, write an adequate description in the Data Logbook. Provide specific details about the problem or issue. Discuss the issue with the project coordinator at the next opportunity.

   Back up the database (C:/ARMI/RockyMountainsARMI.mdb) on the memory device provided.

   Crew members download camera images to the laptop. Remove any photos that are not intended for this project. Store digital images of sampled sites and specimens in a folder called Amphibian_Images within the parent folder in which the local database is stored. Create directories for each catchment under the relevant Park, e.g., C:\ARMI\Amphibian_Images\YELL\4386. If more than one field crew is conducting surveys and taking photos in the catchment, make subdirectories for each crew, for example, C:\ARMI\Amphibian_Images\YELL\4386\Crew1\.

   Following the field season, the project coordinator reviews the images for quality and relevance, resizes original image files larger than 500kb, and ensures that a reasonable number of representative images per site are filed with the project. Original “raw” images can be stored elsewhere if project staff determine it is important to keep higher resolution images. The project coordinator renames images according to the following convention.

Naming convention for site and specimen images:
<PARK_CODE>_<site_code>_<species (for specimen images)>_<description>.jpg
Example: GRTE_4386_amti_egg_mass.jpg

3. Sanitize waders and nets. Thoroughly wash and scrub off mud and debris from all surfaces, especially in between the tread on waders. AFTER all waders and nets look totally clean, dip them in disinfectant. Make sure all surfaces are contacted. Put outside on the line to dry.

4. Clean conductivity and pH meters (if used), thermometer. Rinse in tap water, dip in rubbing alcohol, and then rinse again. If used, calibrate pH and conductivity daily. Record calibration dates and results in calibration log book.

5. Wash voucher photo cups. Wash with dish detergent in hot water, dry with paper towel.

6. Store electronics safely in the locked cupboards.

7. Recharge batteries for field computers, camera, GPS, and radio, as needed.

8. If catchment is complete, put the field maps and forms into the folder for that catchment. Fill out the time/effort summary.

9. Record your time for the day on your timesheet.

10. Call the field coordinator if there is any problem you need to discuss. Promptly communicate any problems with equipment/supplies (loss, breakage, malfunction), and if any wildlife or ranger incidents occur. Also, inform the coordinator about any schedule adjustments; for example, if you finish a catchment early, or cannot finish in the time allotted.

11. Determine where to work the next day, and make sure you have the correct maps and GPS waypoints loaded. Make sure you are clear about what sites have been completed and which still need to be surveyed. Consider how best to cover the area most efficiently. (Can do this in the morning.)

While on Backpack Trips

- Back up your field computer(s) twice daily; mid-day and at the end of every day.
- Record what sites are visited on a daily basis.
- At the end of the day, clean mud from boots and nets; let gear air/sun dry as much as possible.

Standard Operating Procedure (SOP) 4: Monitoring Catchments Not Previously Surveyed

Version 1.0, April 2013

Change History

Original Version #	Date of Revision	Revised By	Changes	Justification	Pages Affected	New Version #

Overview

Most catchments visited have been located and surveyed during the development of this protocol, however, there may be the occasion to survey new catchments when a previously surveyed catchment is no longer suitable (e.g., due to wildlife closure, safety reasons, or other disturbances). The following procedures describe how to establish a new catchment and identify potential amphibian breeding sites within the catchment.

Procedures

National Wetland Inventory (NWI) maps in GIS are used to pre-identify areas that may contain wetlands capable of supporting amphibian breeding within catchments. NWI polygons (representing wetlands with certain attributes assigned) may contain several (or no) potential amphibian breeding sites. Prior to the surveys, the NWI polygons in the catchment were assigned a letter code for temporary use; field crews assign permanent site-ID numbers when they define sites in the field. These letter codes, location coordinates, and NWI wetland type codes are provided on Site Lists. (Refer to Appendix C in the protocol narrative for NWI codes). Field maps show the NWI polygons superimposed on the topographic map. Coordinates near the center of target NWI polygons are uploaded from GIS into the GPS unit.

Instructions:

1. Navigate to the potential sample areas using the field map and the coordinates on the Site List (see SOP 2: Pre-season Preparations and Equipment Setup).

2. Apply the Site Decision Chart (Figure 4-1 below) and Site Definition Guidelines (Table 4-1 below).

   There are three possible designations for target areas:

   a. Currently suitable for amphibian breeding (a survey is conducted);

   b. Potentially suitable at another time (currently dry or inaccessible; marked as a potential site for future surveys); or

   c. Not a wetland and never potentially suitable (no need to return in future years).

3. Starting with the value “1”, assign a unique and consecutive number to all potential sites (surveyed or not) AND to NWI polygons that lack wetland habitat and do not appear to be suitable. Assigning a number to these “not potentially suitable” areas will allow us to record that they were visited.

4. All potential amphibian breeding habitat within the catchment should be defined as sites and surveyed if suitable conditions exist.

5. It is important to stay within the catchment boundary while doing surveys, even if good habitat is close but just over the catchment boundary line.

6. Be on the lookout for and include any potential sites within the catchment that were not identified or targeted using NWI or topographic maps (i.e., are not on your Site List). To that end, crews should walk all low-order streams or low-gradient portions of all stream systems to identify new habitats associated with beaver activity (which is increasing in Yellowstone; Smith and Tyres 2012) or with debris jams.

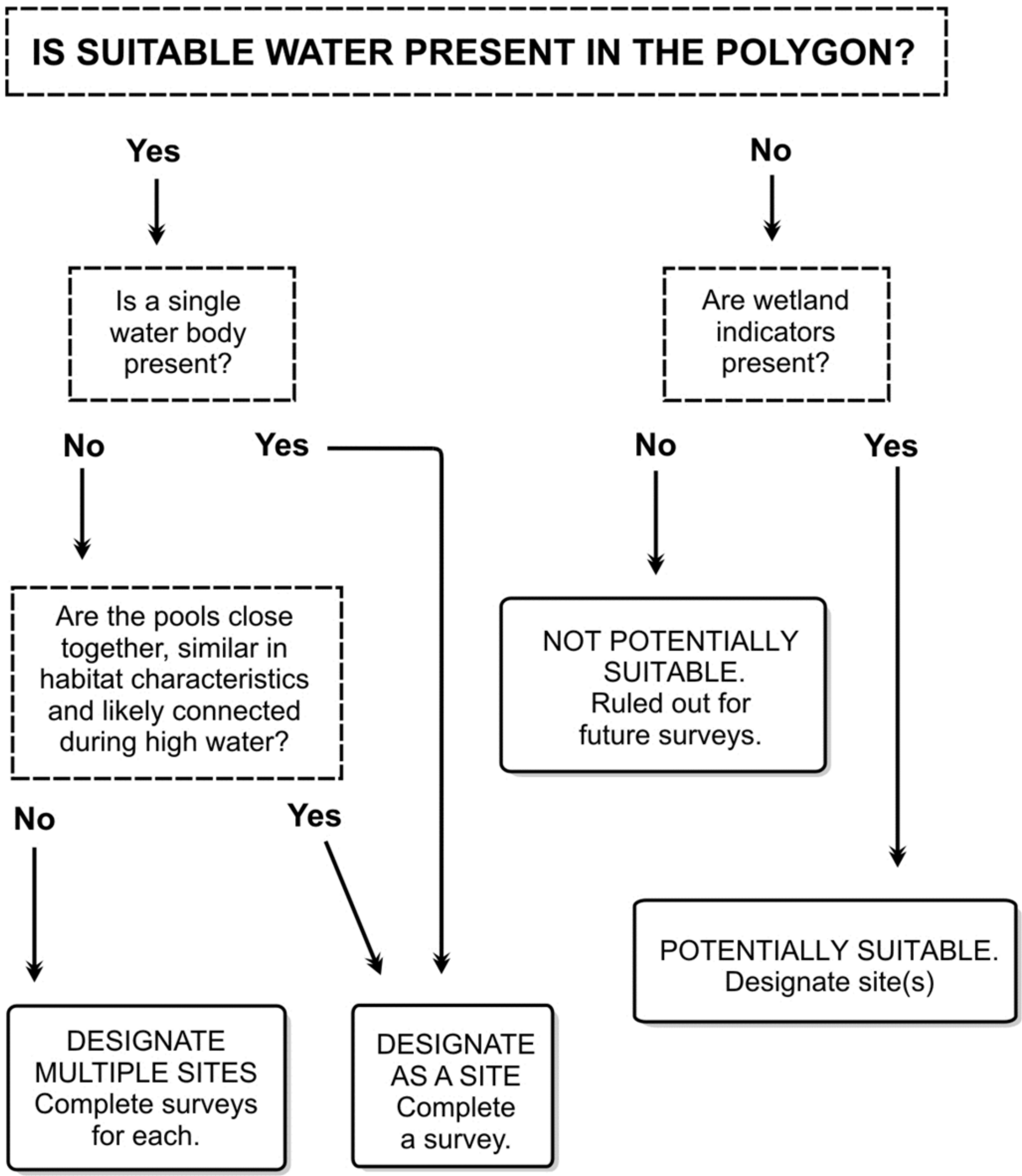


Figure 4-1. Site Decision Chart for defining amphibian breeding sites on initial visit to catchments. There are four potential classifications to use. See Table 4-1 below for explanation of terms.

Table 4-1. Site Definition Guidelines. Terms and categories for site definition, to accompany the Site Decision Chart.

Suitable water	Pooled surface water, excluding extremely ephemeral puddles filled by a recent rain, hot thermal pools, and hillside seeps. Exclude flowing water except if the flow is slight and water is shallow (e.g., <30 cm). Searching a NWI polygon for surface water may entail walking through it, climbing to a high place for an overview and then going to the areas that appeared to be wet or moist, or walking transects through the area if it is large or trees obstruct your vision. Beaver ponds are included as palustrine sites by NWI, but the dams may have washed out by the time of our surveys. These stream sections should be included as “sites” even though water is no longer pooled.
Single water body	A pond or pool occupies all or a portion of the NWI polygon. “Single water body” is the simple case where one NWI polygon corresponds to one site.
Multiple water bodies	One NWI polygon may host a number of ponds, pools, or separated wetlands. Field crews must determine if these should be lumped into a single site or defined as multiple sites.
Are the pools close together?	Less than 10 m between adjacent or neighboring ponds is considered “close.”
Similar in habitat characteristics?	Similar amounts and types of emergent vegetation, similar water gradients (e.g., shallow edges), and similar substrate (e.g., mud).
Likely connected during high water?	Tadpoles could swim from one pool to the other(s).
If multiple pools are lumped as one site	Use the Average Waypoint feature on your GPS unit to acquire coordinates at or near the center of the area designated as the site. Draw the sizes and spatial relationships of the pools in the site drawing. Site length and width pertains to the entire area.
Designate site(s)	Assign a sequential and unique site number.
Suitable water not present	Look for wetland indicators.
Wetland indicator 1	Vegetation: sedges, rushes, willows, the remains of aquatic plants, or plants that have recently grown in a formerly-flooded area. Visible differences in vegetation color, texture, and density compared to upland zone.
Wetland indicator 2	Soil: cracks, color (black or grey are indicators of reduced, low oxygen conditions), or texture indicating past flooding or fluctuating water levels.
Wetland indicator 3	Topography: depressions or concavities suggesting potential to fill with water.
Caveat for large wetlands	*If the polygon is large (>100 m) and complex in shape, sites may be designated to facilitate their relocation in future visits, for example, the narrow arm of a large, wet meadow extending into the adjacent forest could be designated as a site.*

7. Conduct visual encounter surveys (see SOP 6: Conducting Visual Encounter Surveys), *in addition*:

   a. Establish a photo point.

   Select a place that provides a good view of the surveyed area. Use the Average Waypoint function whenever possible on your GPS unit and record the coordinate values (UTM NAD83) and the EPE value on the paper data form, along with the compass bearing of the camera direction and the photo frame number from the digital camera.

   If the site is dry and no survey is conducted, take a photo from the target site's location and record the bearing of camera direction.

   b. Make a drawing of the site.

   Use the reverse side of a data form (see SOP 2: Pre-season Preparations and Equipment Setup). Make sure to define the scale using the grid (e.g., one grid equals 5 meters). Show compass orientation (north arrow), the shapes and spatial relationships of the pools, vegetative features such as emergent vegetation and surrounding forest or shrub stands, adjacent features such as roads or trails, and the location of coordinate acquisition and photo points.

Reference

Smith, D. W. and D. B. Tyers. 2012. The history and current status and distribution of beavers in Yellowstone National Park. *Northwest Science* 86:277-288.

Standard Operating Procedure (SOP) 5: Monitoring Previously Surveyed Catchments

Version 1.0, April 2013

Change History

Original Version #	Date of Revision	Revised By	Changes	Justification	Pages Affected	New Version #

Overview

Most catchments that are visited as part of the GRYN Amphibian Monitoring Program have been located and surveyed during the development of this protocol. Outlined in this SOP are the procedures for monitoring catchments (and their respective sites) that have been visited previously.

Procedures for Monitoring Previously Surveyed Catchments

At sample catchments previously surveyed (2005 through 2012), actual and potential amphibian breeding sites were identified. Despite previous surveys, you may encounter sites within the catchment that were missed or not present (e.g., beaver ponds). All potential amphibian breeding habitat within the catchment should be defined as sites and surveyed if suitable conditions exist. It is important to stay within the catchment boundary while doing surveys, even if good habitat is detected just beyond the catchment boundary line.

The catchment folder (hard copy) contains a list of identified sites, their location coordinates, whether or not the site was surveyed in the previous year, and information on size and number of water bodies. It contains the catchment map (with NWI polygons), with sites labeled to indicate site number and GPS waypoint names. It also contains the previous year's site photos, and the coordinates of photo points. Finally, there is a set of previous site drawings. Take the list, map(s), photos, and sketches with you to the catchment.

Instructions:

1. Navigate to previously identified sites and conduct the survey. Use the site number already assigned. You do not need to enter coordinates for these sites; you will see the electronic Site Form only if you select "yes" for New Site?

2. If you encounter new sites (e.g., new beaver ponds) within a catchment, assign site numbers with a prefix indicating the current year (see SOP 7: Data Field Descriptions and Instructions for Data Entry for more on the Amphibian Monitoring Program's naming convention). For example, in 2013, new sites should start with a Site Number of **131 (where 13=2013 and 1=1st newly identified site in catchment that year)**. Subsequent **new** sites found in that same year and catchment would continue with 132, 133, etc. This strategy is employed so we can be sure that a site number within a given catchment and park that was used in a previous year is not assigned in future years. Since these numbers would be new, they would not appear on your list, because the site was not previously surveyed. For example, the first newly found site in 2013 in Yellowstone's catchment 4603 in the Snake-Henry's Basin, would be identified as YELL_4603_131.

3. When you approach a previously identified site that was surveyed in previous years, consult the site drawing, site photos, and information on the target list to understand how the site was defined. If the provided information does not seem to match with what you see, do the best you can to define the search area/site and make notes of your problems so that they can be discussed later.

4. Conduct the visual encounter survey as per the SOP 6: Conducting Visual Encounter Surveys.

5. Complete a new site sketch only if the previous site sketch is inadequate (site has changed or sketch does not accurately characterize current conditions), or if there is a note that a new sketch is needed (or, of course, for new sites).

6. Enter the photo points into your GPS as waypoints and navigate to the photo point. Use the printed photo and the bearing to orient yourself for the photo re-take. Retake the photo. You

do not need to write down these coordinates unless there is something wrong with the previous photo point and you are establishing a new point (SOP 4: Monitoring Catchments Not Previously Surveyed), or if the given coordinates appear to be in error or influenced by a large estimated position error (EPE).

7. For new sites, make a site sketch and establish a photo point, as described in SOP 4: Monitoring Catchments Not Previously Surveyed.

8. Follow procedures for completing the visual encounter surveys (SOP 6: Conducting Visual Encounter Surveys).

Reminder

Be on the lookout for potential sites within the selected catchments that were missed previously. Our goal is to survey ALL potential amphibian breeding habitat within the catchment. To that end and if time allows, crews should walk all low-order streams or low-gradient portions of all lotic systems to identify new habitats that may be associated with beaver activity (increasing in Yellowstone; Smith and Tyres 2012) or with debris jams.

References

Smith, D. W. and D. B. Tyers. 2012. The history and current status and distribution of beavers in Yellowstone National Park. *Northwest Science* 86:277-288.

Standard Operating Procedure (SOP) 6: Conducting Visual Encounter Surveys

Version 1.0, April 2013

Change History

Original Version #	Date of Revision	Revised By	Changes	Justification	Pages Affected	New Version #

Overview

This SOP describes the procedures for conducting visual encounter surveys for pond breeding amphibians. Visual encounter surveys should be conducted ONLY after completing required documentation for monitoring catchments (SOP 4: Monitoring Catchments Not Previously Surveyed and SOP 5: Monitoring Previously Surveyed Catchments).

Procedure

This SOP describes the procedures for conducting visual encounter surveys for pond breeding amphibians. Visual encounter surveys should be conducted ONLY after completing required documentation for monitoring catchments (see SOP 4: Monitoring Catchments Not Previously Surveyed and SOP 5: Monitoring Previously Surveyed Catchments).

<u>Instructions:</u>

1. Conduct surveys between the hours of 9:00 am and 5:00 pm. Extensions in summer (e.g., 8:00 am to 6:00 pm in late June and July) can be made if lighting is good and air temperature is warm (>12°C).
2. Minimum conditions: Do not conduct surveys during hard rain, or if snow covers the surface or edges of ponds, or if the air temperature is <10°C.
3. Search for amphibians by walking the perimeter of the water body, at the shoreline or in the water within 1 m of shoreline. During this perimeter walk, force yourself to move back and forth between the water's edge and a distance 1 m towards the interior of the water body rather than walking at the water's edge around the entire perimeter. After completing the perimeter walk, make passes through the interior of the wetland using equally spaced transects. Transect spacing should provide good visual coverage of areas between transects. In large, wet meadows or willow-dominated wetlands, transect spacing may be adjusted to ensure good visual coverage of the area. Photographs of the four species (and different life stages) of amphibians present within GRTE and YELL are provided in Figure 6-1. The overall goal of the combined use of perimeter and transect surveys is to provide 100% visual coverage of each wetland.
4. Use polarized sunglasses for better vision into the water. Scan constantly for larvae. Where visibility is obscured by vegetation or cloudy water, make net sweeps at least once every three steps and carefully check the contents of net to see if larvae are present.
5. Postpone initial species identification of larvae until they are caught and examined. Keep track of the species, life stages, and numbers of amphibians observed for inclusion on the data forms (SOP 7: Data Field Descriptions and Instructions for Data Entry) (see Figure 6-1 for representative photos of all life stages of surveyed amphibians).
6. Each person on the two-person field crew conducts an independent survey. The first survey is the "primary" survey; the second is the "replicate." At small sites (e.g., takes <15 minutes to survey), the replicate survey should be done after the first survey is completed. At larger sites, both crew members may survey simultaneously, but should space themselves at a maximum distance (e.g., start from widely separated places). Each person must cover the entire site, keeping track of start time, end time, and any interruptions.
7. Maintain independence of surveys. Do not communicate with each other about findings until both the primary and the replicate surveys are complete.

Boreal toad (*Anaxyrus boreas boreas* = *Bufo boreas boreas*)

Columbia spotted frog (*Rana luteiventris*)

Boreal chorus frogs (*Pseudacris maculata*)

Barred tiger salamander (*Ambystoma mavortium*)

Figure 6-1. Photographs of the four species (and different life stages) of amphibians present within GRTE and YELL.

Standard Operating Procedure (SOP) 7: Data Field Descriptions and Data Entry Instructions

Version 1.0, April 2013

Change History

Original Version #	Date of Revision	Revised By	Changes	Justification	Pages Affected	New Version #

Overview

This SOP provides detailed field descriptions and specific data entry instructions for the GRYN Amphibian Monitoring Program's electronic and hard copy data forms. The SOP also provides a generalized data entry summary on the proper use of personal data assistants (PDAs) for field data collection.

Electronic form data fields are listed in the following tables with detailed field descriptions and specific data entry instructions for each field. These same fields are also used on a paper log form that accompanies electronic data entry.

1. Survey Form (electronic form name is Wetland Survey)		
Data Field	**Description**	**Instructions**
Management Unit	Park units: GRTE=Grand Teton; YELL=Yellowstone	Select from list
Catchment Code	A permanent identification number assigned by GIS. Field crews are informed of this number prior to surveys.	Record the catchment ID number. Make sure this is correct by double checking with most current master catchment map provided by GRYN database manager.
Site Number	A unique number to permanently identify the site. This is assigned by the field crew the first time the site is visited.	Use the previously assigned number. For new sites, assign a number consecutively within the catchment, starting with 1. If two field crews are working, use even and odd numbers (i.e., one crew is even and the other is odd) to assign new sites. For new sites in previously surveyed catchments, use a prefix number to designate the year while providing a unique site number, e.g., '131' for the first new site identified in this catchment in 2013. See SOP 5 for additional details about naming new sites in previously surveyed catchments.
Date	Date of visit to this site.	Automated value based on the date set on the handheld computer. Make sure the date is set correctly as Month/Day/Year.
Recorder	Name or initial of people recording data, select from a list of people working on the project.	Select person recording data for the primary survey. *("Guest 1 or 2" if name is not listed.)*
New Site?	Yes or No. Yes=this site has not been surveyed before (site number just assigned). No=site has been identified previously and already has a site number assigned.	YES if this is an old site, but needs new location coordinates because the existing ones no longer reflect field conditions. This will allow access to the Sites Form where you can enter the new coordinates.
Site Detection	Describes how the site was located. **Previously surveyed:** Not a new site; located using coordinates provided. **NWI**: National wetland inventory polygon. **Topo map**: Pond or wetland identified on a topographic map, but not by NWI. **Incidental**: Potential amphibian breeding site encountered in the field.	Select from the list. *Default is "previously surveyed" for "New site?-No"*

1. Survey Form (electronic form name is Wetland Survey)

Data Field	**Description**	**Instructions**
Survey Conducted?	Yes or No.	Conduct a survey if there is pooled surface water, excluding puddles filled by a recent rain, hot thermal pools, and hillside seeps. Exclude flowing water EXCEPT if the flow is slight and water is shallow (e.g., <30 cm). Do not survey if there is a safety hazard or if wildlife could be displaced from critical activities (e.g., crane on a nest).
If No Survey conducted: Potentially surveyable (at another time)?	Yes or No. **Yes**: Site is possibly suitable at another time (e.g., in a year with more precipitation). **No**: Amphibian breeding habitat is unlikely in any year (e.g., site was misclassified as a wetland, or water is extremely ephemeral).	Look for wetland indicators: (1) Vegetation: sedges, rushes, willows, the remains of aquatic plants, or plants that have recently grown in a formerly-flooded area. Visible differences in vegetation color, texture, and density compared to upland zone. (2) Soil: cracks, color (e.g. black or gray indicated reduced conditions), or texture indicating past flooding or fluctuating water levels. (3) Topography: depressions or concavities suggesting potential to fill with water.
If No Survey conducted: Why not Surveyed/Is it Surveyable?	List of choices: Terrestrial (dry); Too shallow (<2 cm); Slope/Seep; Thermal; Hazard/Inaccessible; Other.	Select from list. Conduct surveys in mild thermal areas, but not in those that are too hot for safety or have unpredictable crusts. *This completes data entry for "No Survey" sites.*
Searchers	Name or initial of people conducting the survey, select from a list of people working on the project.	Select name(s) of the person(s) conducting this survey for amphibians at this site. ('Guest' if not listed.)
Start Search Time	Time the survey begins.	Enter date and time. Month/Day/Year hours:minutes am or pm
% Perimeter Searched	Perimeter of the potential breeding site searched for amphibians during the primary survey, five categories: 1-25; 26-50; 51-75; 76-99; 100.	If the surveyor goes all the way around a pond looking for amphibians, this is 100%. Estimate how much of the breeding habitat was searched in large wetland complexes where 'perimeter' is not clearly relevant.
End Search time	Time that the survey ended.	Enter time. Hours:minutes am or pm
Total Person Minutes of Search	Actual time in minutes spent on the primary survey.	Subtract interruptions (e.g., lunch breaks). If more than one person worked on the primary survey, add their times together.
Field Data Review	Person that reviewed data entries for completeness and accuracy, selected from a list of people working on the project.	Select the name of the person reviewing these entries to ensure that they are correct.
Notes	Comments about this survey.	Describe anything noteworthy or unusual about the survey; note if anything interfered with survey, changes in the area, problems with the data entered, etc.

2. Sites Form		
Data Field	**Description**	**Instructions**
[New Site=Yes] UTM Easting UTM Northing	Coordinates from near center of site using the Universal Transverse Mercator (UTM) system.	Always use averaged GPS coordinates if your GPS unit supports that function–see the GPS user guide. Use GPS to take coordinates from near center of site. Note that Easting always has 6 digits, Northing always has 7 digits. Datum is NAD27; make sure the GPS unit is set NAD27. GRTE and YELL are in zone 12. A transition strategy to NAD83 from NAD27 is currently being developed by GRYN's Data Manager.
[New Site=Yes] EPE meters	Accuracy or EPE (estimated position error in meters [+/- m]) value provided by the GPS at the place where the coordinates were collected.	Make sure the GPS device is set to record units in meters
[New Site=Yes] Check coordinates	Reminder to check and confirm the correct coordinate values	Check the coordinate values for accuracy.
[New Site=Yes] Notes	Comments about this site and its coordinates.	Explain if entering new coordinates for a previously defined site.
3. Weather Form		
Data Field	**Description**	**Instructions**
Air Temp in Shade	Degrees C at 1 m above ground.	Shield thermometer or electronic weather meter from the sun; wait a minimum of 15 minutes or for the thermometer or measurements to stabilize before recording temperature data.
Water Temp	Degrees C at 1 cm below the surface and 1 m from the margin of water body, in the vicinity of amphibian larvae if present.	Thermometer should be left in place for a minimum of 2 minutes or until no discernible change in temperature is detected.
Cloud Cover	Three categories: Clear (0-10% cloud cover); Partly Cloudy (11-80%); Overcast (>80%).	Consider an average of the entire sky and select from the list.
Wind	Three categories: None/light (breeze felt on face, leaves rustle); Moderate (dust rises, small branches move); Strong (small trees sway).	Consider the average of the entire survey and select from the list. Make a note of strong winds or if wind-induced conditions (e.g., surface waves) limit your ability to see through the water surface.
Precipitation	Three categories: None; Rain; Snow/sleet/hail.	Conditions during the survey, select from the list.
Conductivity	Conductivity as measured at the site. *Only included during specific studies.*	Take reading near the location where water temperature was measured. Wait for meter to stabilize before recording (approximately 2 minutes but may be longer under some circumstances). Calibrate equipment daily.
pH	pH as measured at the site. *Only included during specific studies.*	Take reading near the location where water temperature was measured. Wait for meter to stabilize before recording (approximately 2 minutes but may be longer under some circumstances). Calibrate equipment daily.

4. Habitat Form		
Data Field	**Description**	**Instructions**
Dominant Habitat Type	Three categories: lake/pond/pool; marsh/wet meadow/swamp; stream/backwater/oxbow.	Select one from the list; choose the dominant feature if more than one is present. Unless you strongly disagree with the previous designation (on your site-target list); use the category that was previously selected. If you do disagree, provide an explanatory comment.
Beaver Pond?	Yes or No	This includes active and inactive beaver sites; look for old or new dams.
Max Water Depth	Maximum water depth, in three categories: <0.5, 0.5-1; 1-2; >2. (meters)	Make an estimate using the net poles and select from the list.
Ave length Ave width	Average (not maximum) length and width (in meters) of the water body surveyed, or the site surveyed in a wet meadow containing more than one pool.	Smooth out irregular edges (mentally) to estimate average length and width.
Number of discrete water bodies	How many separate pools are in this site? A water body is "discrete" if not connected to others during high water (a tadpole could not swim to it).	Do not count small pools that are less than 10 square meters (10 m^2).
% Shallows	Percent of water body (or bodies) that is <u>50 cm deep or less</u>, six categories: 0%; 1-10%; 11-25%; 26-50%; 51 75%; 76-100%.	Estimate this after you have conducted the survey and are familiar with the site.
% Macrophytes	Percent of water body with emergent or aquatic plants, six categories: 0%; 1-10%; 11-25%; 26 -50%; 51-75%; 76-100%.	To estimate, for example, if you take 20 steps to cross the water body, how many of these steps would fall in the vicinity of emergent or aquatic plants? If 10 of 20 steps, this is the 26-50% category.
Dominant Wetland Macrophyte	sedges/rushes/grasses; bulrushes/cattails; pond lily; shrubs (e.g., willow); other	"'Other" is usually used for aquatic plants and algae.
Dominant Substrate in Shallows	Five categories: mud/silt/vegetation; sand; gravel; cobble; boulder/bedrock.	Select the dominant one that best characterizes the site. "Vegetation" refers to plant matter on the pond bottom.
Fish detected?	Yes or No	Record "Yes" only if fish were actually seen during either the primary or replicate survey.

5. Species Form (electronic form name is RMSpecies, signifying Rocky Mountain species)		
Data Field	**Description**	**Instructions**
Type	Select: Amphibian or Reptile	
Species	List of potential species. Amphibians AMTI (AMMA)=barred tiger salamander; BUBO (ANBO)=boreal (western) toad; PSMA=boreal chorus frog; RACA (LICA)=American bullfrog; RALU=Columbia spotted frog; RAPI (LIPI)=northern leopard frog. *If confident with your identification consider making note of reptiles encountered in the field.* Reptiles CHBO=Northern rubber boa; CRVI=prairie rattlesnake; PICA=Bullsnake; SCGR=Northern sagebrush lizard; THEL=wandering gartersnake; THSI=valley gartersnake.	Note that the codes are based on scientific names, e.g., AMTI=*Ambystoma tigrinum*. See training materials for complete taxonomy. AMTI indicates *Ambystoma tigrinum* and BUBO indicates *Bufo boreas,,* however, current taxonomic authorities recognize these species as *Ambystoma mavortium and Anaxyrus boreas* (Frost et al. 2011)
Life Stages Detected	Four categories, multiple selection allowed: Egg; Larvae; Metamorph *(recently transformed & able to live out of water, young-of-the-year)*; Juv/Adult *(metamorphosis occurred in previous year(s))*.	Select as many as applicable. Scroll down the list to see all the choices
Detection method	Three choices: visual, auditory, handled	This applies only to young of the year, if multiple life stages are detected. Visual is default and means you saw but did not catch the animal. “Handled” if you got the species in the net or hand. Auditory if you only heard the species (e.g., use for chorus frogs [PSMA] that you hear calling but do not see).
No. Juv/Adults	The actual number of adult and juvenile of this species seen on this survey.	Juveniles have adult form but are smaller. Do not include young of the year (i.e. larvae or metamorphs). Skip if none.
No. Larvae/Metamorphs	Estimate of the number of young of the year that were seen, grouped in 5 categories: 0; 1-10; 11-100; 101-1000; >1000.	Keep a rough count of larvae and metamorphs as you conduct the survey so that you know when you have seen more than 10, more than 100, etc. Put the actual estimate of young of year and egg masses observed in the Notes section (e.g., 45 RALU tadpoles).
Voucher Collected?	Four categories, select as many as apply: Museum Voucher (formalin); Genetic Voucher (alcohol); Photo Voucher; None	In YELL and GRTE, voucher photos were historically used to verify identifications. This field has had little use since 2008 but can be used for confirmatory purposes.
Notes	Comments about the species at this site.	Use this field to describe any dead or sick found of this species (number found, details), or anything you think is important relating to this species at this site. If you took a voucher species photo, write “PID *photo frame number.”*

6. New Replicate Form

This subform is used to record the second survey at this site (same day).

Top of screen on the handheld computer displays park, catchment, and site number if keypad is maximized.

Data Field	Description	Instructions
VisitNumber	To differentiate Primary (1) and Secondary or Replicate (2) surveys.	No user action required–this is automatically set.
Date	Date of survey.	Automated value based on the date set on the handheld computer. Make sure the date is set correctly.
Recorder2	Name or initial of people recording data for the replicate survey, select from a list of people working on the project.	Select name of the person entering the electronic data for this replicate survey. (Use “Guest” if the person’s name is not listed.)
Searchers2	Name or initial of people conducting the replicate survey, select from a list of people working on the project.	Select name(s) of the person(s) conducting the replicate survey for amphibians at this site. (Use “Guest” if the person’s name is not listed.)
Start Search Time2	Time that replicate survey begins.	Enter time that the replicate survey began.
End Search Time2	Time that the replicate survey ended	Enter time.
% Perimeter	Perimeter of the potential breeding site searched for amphibians during the replicate survey, five categories: 1-25; 26-50; 51-75; 76-99; 100.	Enter the category that reflects the percentage of the perimeter that was surveyed.
Total Person Minutes	Actual time in minutes spent on the replicate survey.	Subtract interruptions. If more than one person worked on the replicate survey, add their times together.

7. Paper Log Form. This form is used to complement electronic data entries in the field and contains a subset of the data fields available in the table above. This form assists with data quality control, provides a location for a site drawing, and a place to include additional notes.

For use with PDA

YELL GRTE Catch# __________ Site# __________ Crew: __________

Date: ______________ Arrive time: _____________ Survey: YES NO

PHOTO(s) (List UTMs for a new site, or if different from those provided)

Frame #: __________ Bearing: __________

Easting:_______________ Northing: _________________ ± _____ m

Frame #: __________ Bearing: _________

Easting:_______________Northing: __________________ ± _____ m

SPECIES DATA (backup)

Survey 1 or 2	Species	Life Stage E, L, M, J/A	Number 1-10, 11-100, 101-1000 >1000	Note / Code

NOTES

Park, Catchment, & Site ____________________ **Date:** _____________

Grid Scale ___________

Indicate: (1) North; (2) location where site utm was collected; and
(3) the location & direction of site photos.

8. Field Data Sheet Form. This subform is used to record amphibian (and reptile) observations from replicate surveys. Data are entered in fields identical to the RMSpecies fields (Form 5 above).

UNIT: YELL GRTE | Catchment: ________ Site: ________ Date: __________ Recorder: ________

New site? **YES** >> Easting: ______________ Northing: _________________ ± ______(m)

Site detection (circle one): NWI unit Topo map Incidental

Survey conducted? >>> **NO** >> Potentially suveyable at another time?: **YES** **NO**

v v v v v **Why not surveyed?**: Dry Too shallow Slope/seep Hot thermal Hazard Inaccessible Other

YES >> Searcher(s): ____________________ Start Time: ______ End Time: ______ Total min: _______

Percent Perimeter Searched: 1 - 25% 26 - 50% 51 - 75% 76 - 99% 100%

WEATHER | **Air temp** ____C **Water temp**____C **Sky:** Clear (0 - 10%) Part cloudy (11 - 80%) Overcast (>80%)

Wind Average: none/light moderate strong **Precipitation during survey:** none rain snow/sleet/hail

HABITAT | **Dominant habitat type:** lake/pond/pool marsh/wet meadow stream/backwater/oxbow

Beaver pond: **YES** **NO** | **Max Water Depth (m)**: <0.5 0.5-1 1-2 >2

Avg site length : ______m **Avg width**: _______m | **Number of discrete water bodies**: ___________

% shallows: 0 1-10 11-25 25-50 51-75 76-100

% Emergent & Aquatic Plants: 0 1-10 11-25 25-50 51-75 76-100

Dominant Wetland Vegetation: sedge/rush/grass bulrush/cattail pond lilly shrub other

Substrate: mud/silt/vegetation sand gravel cobble boulder/bedrock | **Fish detected?** **YES** **NO**

SITE PHOTO(s) (list UTMs for a new site, or if different from those provided for this previously-surveyed site)

Frame #: _____ Direction (bearing): _____ Easting:_________ Northing: ______________ ± _____m

Frame #: _____ Direction (bearing): _____ Easting:_________ Northing: ______________ ± _____m

REPLICATE SURVEY (Survey 2, same date) | Recorder: ________ Searcher(s): ____________________

Start Search Time: ______ End Search Time: ________ Total minutes: ________

Percent Perimeter Searched: 1 - 25% 26 - 50% 51 - 75% 76 - 99% 100%

SPECIES DATA | **Life History Stages, choose**: E (egg) L (larvae) M (metamorph) J/A (juvenile and/or adult)

Number of Larvae & Metamorphs, choose: 1-10 11-100 101-1000 >1000

Detection Method, choose: Visual Handled Auditory

Survey 1 or 2	Species	Life Stage	Number	Detection Method	Photo frame	Comments (e.g., number dead)

Field Data Sheet Form (reverse side)

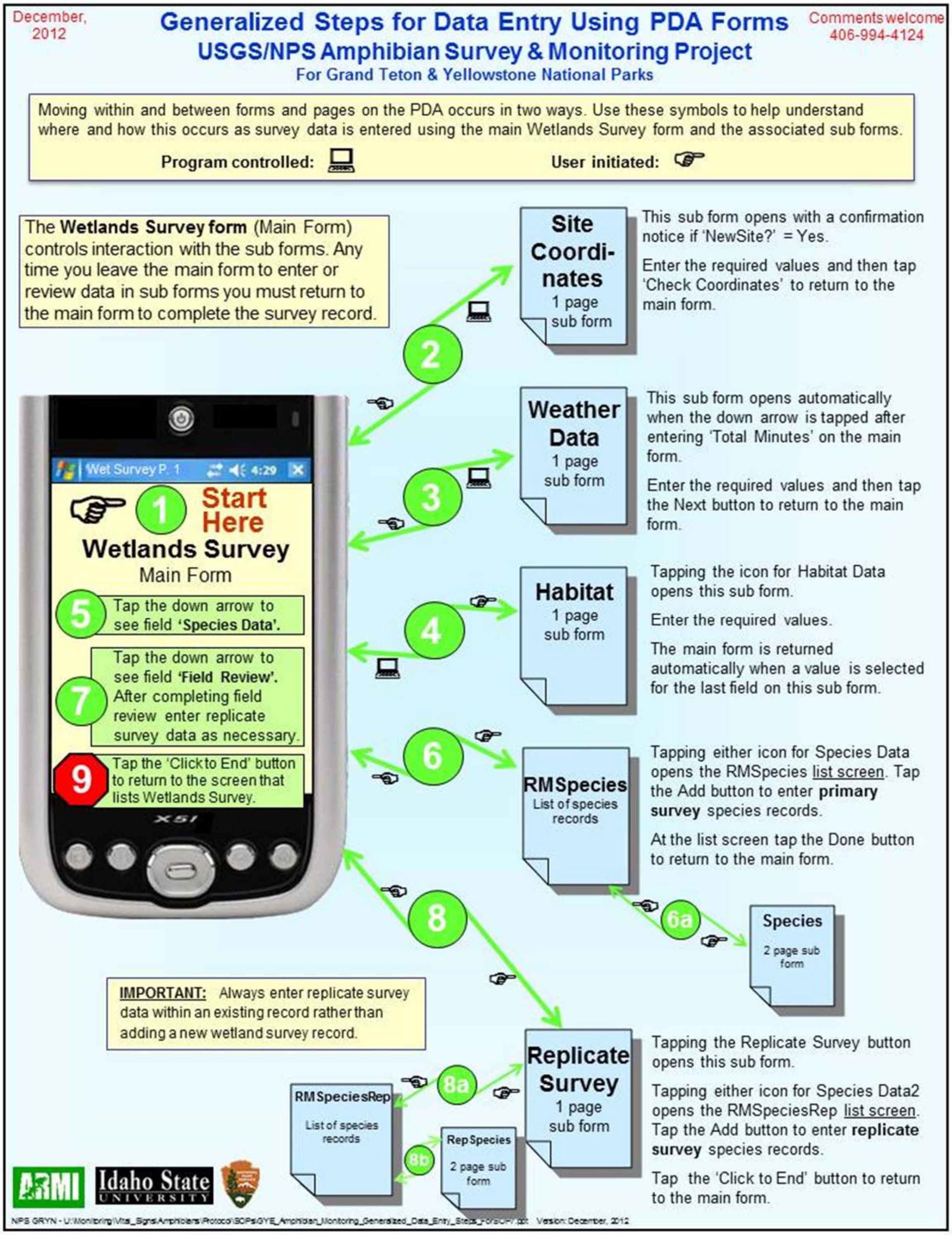
Site Map

Park, Catchment & Site Number: _______________ **Date**____________ **Grid Scale**: _______

												N↑		

Indicate where in drawing GPS point was collected, and the location/direction of site photo(s).

NOTES:


December, 2012
Generalized Steps for Data Entry Using PDA Forms
USGS/NPS Amphibian Survey & Monitoring Project
For Grand Teton & Yellowstone National Parks
Comments welcome 406-994-4124
Moving within and between forms and pages on the PDA occurs in two ways. Use these symbols to help understand where and how this occurs as survey data is entered using the main Wetlands Survey form and the associated sub forms.
Program controlled:
User initiated:
The Wetlands Survey form (Main Form) controls interaction with the sub forms. Any time you leave the main form to enter or review data in sub forms you must return to the main form to complete the survey record.
Wet Survey P. 1
4:29
1
Start Here
Wetlands Survey
Main Form
5
Tap the down arrow to see field 'Species Data'.
7
Tap the down arrow to see field 'Field Review'. After completing field review enter replicate survey data as necessary.
9
Tap the 'Click to End' button to return to the screen that lists Wetlands Survey.
X51
2
Site Coordi- nates
1 page sub form
This sub form opens with a confirmation notice if 'NewSite?' = Yes.
Enter the required values and then tap 'Check Coordinates' to return to the main form.
3
Weather Data
1 page sub form
This sub form opens automatically when the down arrow is tapped after entering 'Total Minutes' on the main form.
Enter the required values and then tap the Next button to return to the main form.
4
Habitat
1 page sub form
Tapping the icon for Habitat Data opens this sub form.
Enter the required values.
The main form is returned automatically when a value is selected for the last field on this sub form.
6
RMSpecies
List of species records
Tapping either icon for Species Data opens the RMSpecies list screen. Tap the Add button to enter primary survey species records.
At the list screen tap the Done button to return to the main form.
6a
Species
2 page sub form
8
IMPORTANT: Always enter replicate survey data within an existing record rather than adding a new wetland survey record.
Replicate Survey
1 page sub form
Tapping the Replicate Survey button opens this sub form.
Tapping either icon for Species Data2 opens the RMSpeciesRep list screen. Tap the Add button to enter replicate survey species records.
Tap the 'Click to End' button to return to the main form.
8a
RMSpeciesRep
List of species records
8b
RepSpecies
2 page sub form
ARMI
Idaho State UNIVERSITY
Version: December, 2012

Data Entry Tips for PDA Forms - ARMI/GYE Amphibian Monitoring

Helpful Hints:

Use the arrows and the Next button at the bottom of the screen to navigate the forms. Avoid tapping 'X' in the upper right corner of the screen.

Records cannot be deleted on the PDA. This prevents inadvertent data loss but requires writing clear explanations for PDA records that need to be removed later from the master database.

Catchment and site numbers should not be changed on the PDA. Instead, write a clear explanation of the necessary change for later action by the Crew Leader or Database Administrator.

Open a sub form after the required data is collected/recorded, and be prepared to enter data for each field in a subform while the subform is open.

Input a valid answer or data value in all data fields for every page of every form. Write a note on paper explaining all exceptions or issues.

Before entering text in a 'Notes' field, check the page title to make sure the note corresponds to the correct topic.

When in doubt about whether or not data have been successfully recorded, write the data on a paper form.

If duplicate or contradictory records may have been entered, **make notes** to describe what happened.

To close and exit the Forms5.1 application (otherwise it's only hidden), first ensure the main Pendragon Forms screen is showing where 'Wetlands Survey' is listed. Then tap the Switcher Bar and tap Exit current program.

Issue Resolution:

Message: **Unable to restore this record to its previous state.**
Solution: Tap Ok (the only choice). Make a note in the log book to check the affected catchment ID and site ID records in the data tables following upload to the main database. To complete the record tap Review from the Wetland Survey screen, select the pertinent record, and navigate to the appropriate page and form.

Issue: **Device doesn't respond (freezes)** when tapping the display or pressing the buttons, or won't power on.
Solution: Make sure the battery cover latch is properly closed and try again. If securing the battery cover latch doesn't help, perform a soft reset by using the stylus to press the reset button on the back of the device.
Performing a soft reset preserves saved data and installed applications. The current record may not be complete so make a note for the Crew Leader.

Issue: **Memory card not recognized** when trying to perform a Backup.
Solution: Perform a soft reset (see instructions above).

Issue: **The Catchment Code or Site Number needs to be changed on the PDA.**
Solution: Do Not change the catchment code or site number on the PDA. Write a descriptive note explaining the correct and incorrect catchment code and site number in the field logbook. The Crew Leader will use this information later to change multiple records in multiple tables **after** the data is transferred to the database on the main computer.

Issue: **The PDA won't synchronize with the computer.**
Solution: Disconnect the PDA from the computer. Close ActiveSync on the PDA using the Switcher Bar. Wait 30 seconds. Reconnect. Repeat this procedure if necessary. If the PDA still won't connect, reboot the laptop and try again.

Issue: **A Wetland Survey record was started that now needs to be deleted.**
Solution: Tap 'Click to End' (Exit Record) when this choice is available. If prompted for a missing response (due to skipping required fields) tap 'Undo all changes'. Make a note with the catchment code and site number in the field logbook.

PDA Tips:

Load and use the Switcher Bar (tap Start → Settings → System → Switcher Bar) to check for and close unneeded applications, manage power and screen brightness.

Use the lock buttons switch (Axim X51 model) to prevent accidentally powering the unit on when the device is not in use.

Use electrical tape to cover unneeded buttons and ports.

Don't tap the screen with a sharp object. If the stylus gets lost use a small stick with a blunt tip.

Do not let the unit sit in direct sunlight for prolonged periods.

Do not leave the unit (covered or uncovered) in the sun within a closed vehicle.

Tie or tape bright colored material to the device and/or case to avoid losing sight of the equipment in the field.

Use the power off/quick power up feature while counting, measuring, observing, etc. to maximize battery life.

In Start → Settings → Buttons, assign all the buttons to <None> to prevent inadvertent launching of programs.

Launch a program by tapping its icon only once, and wait patiently while the program loads. Tapping an icon multiple times can open multiple instances of the same program with no warning to the user. Check for and close duplicate applications from the Switcher Bar.

A hard reset deletes all user data and applications. Do this only as a last resort after consulting with the project leader and/or data manager. After a hard reset the handheld will need to be reconfigured and reloaded with the data collection application(s).

Standard Operating Procedure (SOP) 8: Data Analysis

Version 1.0, April 2013

Change History

Original Version #	Date of Revision	Revised By	Changes	Justification	Pages Affected	New Version #

Overview

This SOP provides a conceptual description of the occupancy modeling approaches described in the GRYN Amphibian Monitoring Protocol and a detailed description of input strategies for entering monitoring data into two software programs. The framework described has been adopted by the GRYN Amphibian Monitoring Program and used to achieve the following goals: (1) to track and estimate changes in the distribution and occurrence of breeding amphibians within Grand Teton (GRTE) and Yellowstone's (YELL) wetlands, and (2) to evaluate whether the amphibian *vital sign* could be used to assess the status and condition of wetland ecosystems and their associated biodiversity in GRTE and YELL over time. Our approach employs a measure of species occurrence (occupancy) as the primary indexing analysis because this approach has become the "gold standard" method to assess status and trends of amphibians across large landscapes (Bailey et al. 2004, Bailey and Adams 2005, Corn et al. 2005, Schmidt 2005). In brief, occupancy modeling of amphibians relies on presence and absence data collected during multiple surveys of a potential breeding location (i.e., wetland site) within permanent watershed units (i.e., catchments). Results from these surveys (i.e., detection histories) can then be used to estimate the 1) probability of detecting a species given its documented detectability and the 2) probability that a wetland site or catchment is occupied by amphibians (Bailey and Adams 2005). Occupancy can be modeled for a single species in a single season, for a single species over multiple seasons, or for multiple species over single or multiple seasons (MacKenzie et al. 2006).

Using this occupancy modeling framework it is possible to characterize patterns of native amphibian occupancy within GRTE and YELL and explore whether occupancy estimates for different species vary across sample years, strata (e.g., designated habitat quality classes and distance to roads), and major hydrologic subbasins (e.g., Yellowstone, Snake-Henry's, Madison-Gallatin). Detection of differences in occupancy across years is important for trend monitoring and can be achieved in multiple ways. For example, an evaluation of species-level occupancy trends can be completed using an explicit dynamics modeling approach that incorporates a time component, varies by habitat class, access class, and major subasin, and ultimately produces probabilities of occupancy that may change across years (MacKenzie et al. 2006). Alternatively, annual estimates of occupancy can be examined together using recognized regression approaches, and the slope (β_i) of the line estimates the trend parameter across years using a logit link function (MacKenzie et al. 2006). A thorough description of the occupancy estimation and modeling is available in MacKenzie et al. (2006) and a description of the approaches applied to occupancy modeling of amphibians in Greater Yellowstone Ecosystem are discussed in Gould et al. (2012). What follows is a general overview of the description of the techniques and software programs that can be used to produce occupancy estimates. This section is not intended to be expansive and the reader is directed to authoritative sources (e.g., MacKenzie et al. 2006) for more detailed descriptions of the assumptions and range of approaches to occupancy modeling or to User's Manual's of software packages designed to aid in occupancy estimation.

Objective of Analyses

Before initiating any type of occupancy estimation for amphibians within GRTE and YELL, the analyst should first decide what type of analysis is desired. Occupancy can be modeled for a single species in a single season, for a single species over multiple seasons, or for multiple species over single or multiple seasons. Please refer to MacKenzie et al. (2006) for an authoritative description of each approach.

Deciding on the Spatial Scale

The sampling design for GRTE and YELL uses amphibian species occurrences across catchments (portions of watersheds *sensu* Franken 2004) and within potential breeding sites or wetlands. Catchments are the primary index measure with which to measure amphibian population health, but the analyst has the ability to estimate occupancy at individual sites (e.g., wetlands, ponds, wet meadows, etc.) nested within catchments. As a result of the hierarchal organization of sites and catchments, amphibian surveys within GRTE and YELL produce results for significantly more sites than catchments. Consideration of both scales is important for trend monitoring because climate or other environmental factors that affect occupancy or other dynamic parameters (e.g., colonization and extinction) have differing effects on catchments than on individual sites. For example, Gould et al. (2012) demonstrated that permanent and seasonal wetlands had distinctly different occupancy rates. And, a substantial reduction of seasonal wetlands within a catchment could occur but this loss would not be noticed if only catchment-level occupancy estimates were employed exclusively. Based on the considerations described above, the analyst is encouraged to consider estimating occupancy at both spatial scales.

Estimating Occupancy for One or More Years

After determining the goals and scale (catchment or site-level) of the analysis, the analysts should determine whether a single or multi-year estimate is desired. Multi-year occupancy estimates are likely to be more important for trend monitoring than production of individual or yearly occupancy estimates. Explicit dynamic models (MacKenzie et al. 2003) have been used successfully to estimate occupancy over multiple years within GRTE and YELL (Gould et al. 2012). These models use annual estimates of colonization and extinction rates to describe the processes underlying changes in occupancy for individual species over multiple years.

Prior to developing potential models to estimate occupancy, species-specific detection probabilities should be estimated using presence and absence data from field surveys and by presenting all other variables in their most basic form and without covariates. With respect to GRTE and YELL, initial occupancy should be allowed to vary by stratum and year (see Gould et al. 2012). The highest ranked detection models then can be used in evaluations of dynamic parameters: colonization and extinction rates. These dynamic parameters should be treated carefully and should vary in the same manner (e.g., if extinction rates are determined to be stratum-specific, then colonization should be treated similarly). In the GYE it is possible to estimate occupancy using models where colonization and extinction rates are habitat and/or access-specific (see Gould et al. 2012). The analyst should refer to the benefits and drawbacks of different modeling approaches described in MacKenzie et al. (2006).

Finally, once a suite of candidate models for estimating occupancy are developed, model selection techniques should be used to examine the goodness of fit for a set of candidate models. The Akaike's Information Criteria (AIC) corrected for small sample size is an appropriate tool for evaluating a set of candidate models (Burnham and Anderson 2002). In general, as differences in AIC become smaller, so does the statistical basis for distinguishing among alternative candidate models (Burnham and Anderson 1992). Candidate models should be compared to the model with the minimum AIC (or AICc) by using a table of differences in AIC (ΔAIC). As a rough rule of thumb, all models with AIC differences of less than 2 are viewed as having a substantial level of empirical support, differences of 4-7 have substantially less support, and greater than 10 have essentially no support (MacKenzie et al. 2006). However, models with AIC differences greater than 2 may still warrant consideration, such as by using AIC weights for deriving parameter estimates from model averaging. In general, the analyst should review the rules for model selection for AICc carefully and should recognize there is always uncertainty involved with the model selection process (Burnham and Anderson 2002).

Data Presentation

Once occupancy estimates have been derived, there are numerous ways that occupancy data can be presented (see Figures 8-6 and 8-7 as examples). For example, occupancy estimates can be summarized by species and across years for all species present in sample catchments or sites. Similarly, occupancy probabilities can be summarized by species and year separately for different strata (see Gould et al. 2012). Finally, occupancy can be modeled as a continuous variable with confidence intervals and as a function of catchment-level (e.g., proportion of wetland area within a catchment) or site-level (e.g., abundance of emergent vegetation) covariates (see Gould et al. 2012). As an example, Gould et al. (2012) present a summary of how the catchment-level initial occupancy probability for tiger salamanders varies as a function of average nearest wetland neighbor distance.

An Introduction to Software that supports Occupancy Estimation

There are at least two software programs well equipped to assist with occupancy estimation. These programs yield identical estimates of detection and occupancy. The introduction to these programs follows but is not intended to provide an endorsement of either program. Instead, we briefly describe how to input survey data into each program. Once data is entered, the analyst is encouraged to refer to the User Manuals available online (PRESENCE http://www.mbr-pwrc.usgs.gov/software/presence.html and MARK http://www.warnercnr.colostate.edu/~gwhite/mark/mark.htm) to carryout occupancy estimation following the conceptual framework described above and using the rules and assumptions described in MacKenzie et al. (2006).

The program PRESENCE was developed specifically to enable estimation of the proportion of area of occupied (PAO), or similarly, the probability a site is occupied by a species of interest according to the model presented by MacKenzie et al. (2002). The version of PRESENCE, used for this SOP, is version 2.0; updated versions of PRESENCE are released regularly. PRESENCE was developed by Darryl MacKenzie of Proteus Research & Consulting Ltd. (http://www.proteus.co.nz/) in collaboration with the USGS Amphibian Research and Monitoring Initiative (ARMI) (http://armi.usgs.gov/). PRESENCE and the associated User's Manual are freely available for download at: http://www.mbr-pwrc.usgs.gov/software/presence.html.

Estimation of detection and occupancy is also supported by the more general program MARK (White and Burnham 1999), designed to estimate parameters for a variety of models, and mostly related to marked individuals that are re-encountered over time. MARK was developed by Gary White of Colorado State University (http://www.warnercnr.colostate.edu/~gwhite/). MARK is freely available for download at: http://www.warnercnr.colostate.edu/~gwhite/mark/mark.htm.

The advantages of using one program over another are largely personal preference, but in general PRESENCE will have the most recent updates as this is the software being developed in conjunction with theoretical advancements. However, most updates are incorporated into MARK after a reasonable lag period, and MARK generally has more powerful and intuitive model building capabilities. Since the authors of both programs freely communicate and collaborate, the best qualities of both programs are constantly merging over time.

Data Inputs

Getting data from a database into the proper format is dependent on how each data set is stored. We do not provide explicit instructions for this task; however, we can reasonably describe the general format needs and how to get it into the software.

The general format for data is similar between the two programs. The data formats will generally consist of three main parts: (1) site name or an individual sample unit identifier, (2) encounter histories, and (3) analysis groups or covariates.

Site Name or Individual Sample Unit Identifier

This column is simply a unique identifier for the sample unit being analyzed. In GRTE and YELL the sample unit is available at two scales: catchments and sites within catchments. Catchments have unique ID numbers provided by the GIS layer. Sites have unique IDs that combine the relevant catchment number and a site number assigned in the field, and unique within the catchment.

Encounter (or Detection) Histories

For each sample unit identified, there should be a corresponding encounter history for each species (Table 8-1). This represents the outcome of each sampling occasion and summarizes species observations. If the species is observed at a given site during a sampling occasion, then a "1" is recorded; otherwise it is a "0." The resulting data constitute a matrix where the number of rows corresponds to the number of unique sites and the number of columns (of the encounter history) corresponds to the number of sampling occasions. If a given site was not sampled during a given occasion, "-" is recorded to indicate that it was not sampled. It is very important to distinguish a "0", which indicates that a given site was sampled and the species was not observed, compared to a "-", which indicates that the site was not sampled; therefore the species could not have been observed.

Table 8-1. Some possible encounter histories for a program with three sampling occasions.

Encounter History	Description
1 1 1	Species was observed on a given site during all three sampling occasions.
1 1 0	Species was observed on a given site during sampling occasions one and two, but not on sampling occasion three.
1 0 1	Species was observed on a given site during sampling occasions one and three, but not on sampling occasion two.
0 1 0	Species was observed on a given site during sampling occasion two, but not on sampling occasions one and three.
0 0 0	Species was not observed on any sampling occasion for the given sampling unit.

Analysis Groups and Covariates

In many cases, the probability of occupancy and the probability of detection can be influenced by other factors. Program PRESENCE makes the distinction between two types of covariates. Site-specific covariates are covariates that are constant for a site within a season. Examples might be habitat type, distance to nearest road, and other physical features. These covariates do not change over time. In contrast, sampling-occasion covariates are covariates that may change with each survey of a site, for example, local environmental conditions such as temperature, precipitation, cloud cover, time of day, or observer. Based on the current model structure, detection probabilities may be functions of either site-specific or sampling-occasion covariates, while all other parameters may be functions of site-specific covariates. The limitation of parameters other than detection being limited to site covariates is based on an assumption that occupied sites are occupied for the duration of the sampling occasions within a given year (model assumptions are described in Appendix E of the protocol narrative). It is common for occupancy to be influenced by some attributes that are dynamic. Using seasonal averages or other aggregated measures will sometimes enable this limitation to be considered, but caution is advised to ensure that this represented a true site covariate, rather than a violation of model assumptions.

Extracting Presence-Absence Data from the Amphibian Database

USGS-ARMI has provided an Interface Tool for extracting data out of the Rocky Mountains ARMI databases (which includes GRYN's GYE database). This tool has a "PAO file generator" that can be used for catchments or catchments + sites. After running the generator, maximize the window and select all (using Ctrl A), copy and paste into Excel to manipulate the data. It may be easiest to copy current year data by deleting other survey years' columns and S3 and S4 columns. *Note that "S" refers to the survey number, i.e., 2 surveys (dual observer) for sites*. Accordingly, S3 and S4 do not have relevance for GRYN data. For a single-year analysis, sort and delete all the rows that have "-" "-" in the S1 and S2 columns. These are catchments that were not surveyed, or which had no potential sites (e.g., all wetlands were dry). Use copy/paste to get the values into the PRESENCE data input window, as described below.

Entering Data into PRESENCE

Entering data into PRESENCE depends upon whether the project is new (i.e., new sites or new catchments) or is related to ongoing data from a previous analysis. If a “new project” is selected within PRESENCE, and a project specifications window appears; specifications for the new project are entered, including file names associated with the project and the number of sites, sampling occasions, site covariates and sampling covariates (Figure 8-1). Once the opening window is completed, the easiest way to get data into PRESENCE is to cut and paste from a spreadsheet. To do this, click on the “Input Data Form” button on the opening window and the encounter histories can be cut and pasted into the “Presence-Absence data” section (Figure 8-2). Select all the site/sample data (no headers or other fields), from the spreadsheet and click “Edit/Copy” from the menus. Then, go back to PRESENCE, and click “Edit/Paste.” Once the data are entered, click “File/Save” from the menu, then click “File/Close.” Next, click the “select file” button on the “enter specifications” form, and use the Windows file selector to navigate to the folder where the saved file resides and select the file. After filling out the form, click the “OK” button to create the PRESENCE project file. This will close the specification window and open a “Results summary” window. You are now ready to compute estimates under pre-defined models, or build your own “Custom” model.

If there are covariate data, they can be entered in the same way by clicking the appropriate tab. If the site covariate tab is selected, one column for each covariate listed in the initial window is shown. For sampling occasion covariates, one column for each sampling occasion for each covariate is shown. Also included on the input form is an option of simulating data (single-season model only at this time). This is useful if you are just trying the program and have no data, or if you would like to design an experiment and would like to know how many sites/samples are needed to get a desired level of precision. Both presence-absence data and covariate data may be simulated.

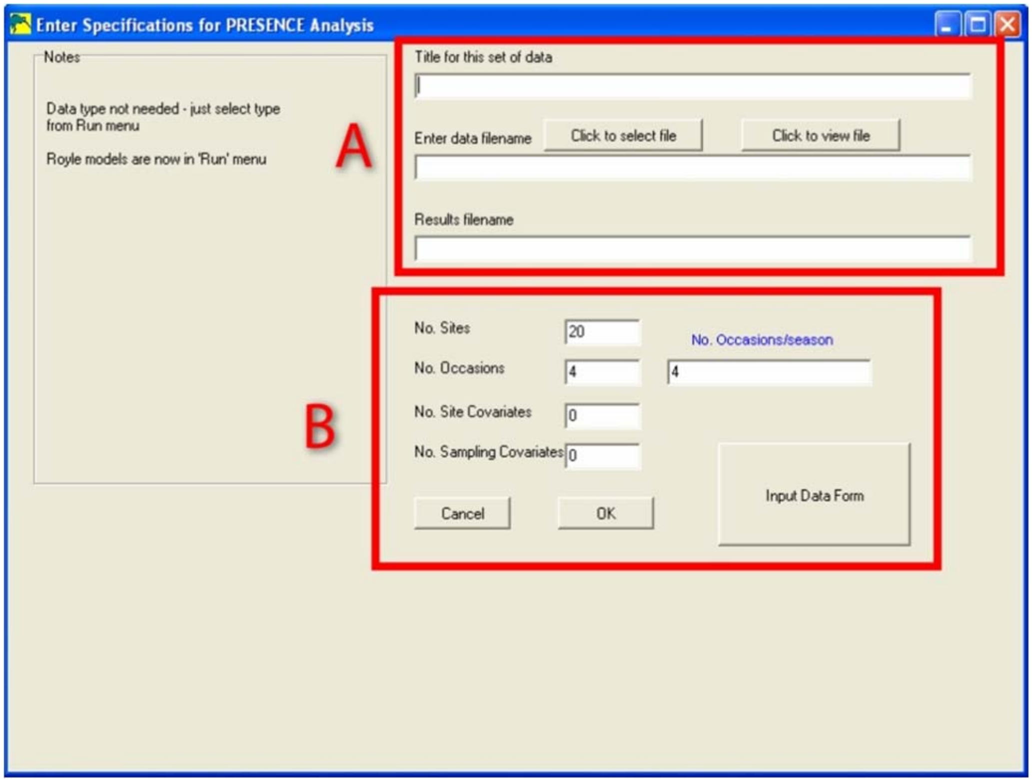


Figure 8-1. For a new project in PRESENCE, a window enables specifying the project title, input data and results file names (A), as well as the number of sites, number of sampling occasions, number of site covariates (see below), number of sampling covariates, and the number of occasions per season (B).

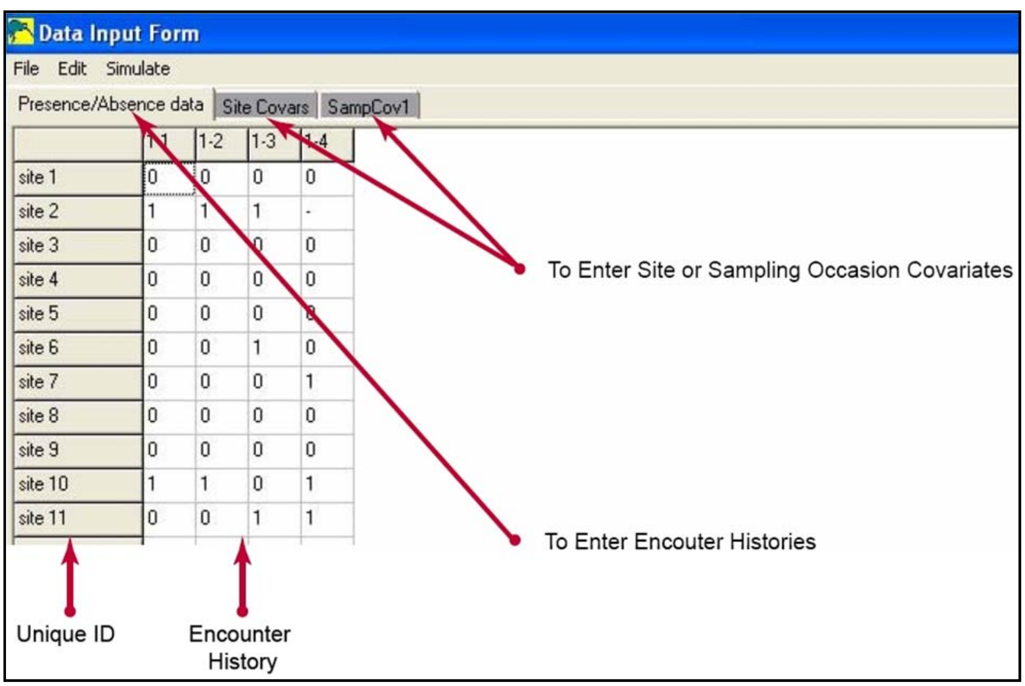


Figure 8-2. Encounter histories can be easily entered into PRESENCE by cutting and pasting it from a spreadsheet. Site and sampling occasion covariates are entered the same way by selecting the appropriate tab.

Getting Data into MARK

As with PRESENCE, MARK will also start with an opening window. However, unlike PRESENCE, in MARK the type of data (Occupancy) must be specified (Figure 8-3). This is because MARK is a more general program capable of analyzing data from a wide variety of population models. The remaining inputs (file names and model specifications) are similar to PRESENCE, except that MARK enables entering the names of covariates at this point, and also allows attribute groups (see below) to be identified.

Entering data into MARK is somewhat different than PRESENCE, although the basic structure of the original data files are virtually the same. For MARK, data are entered via an "Encounter Histories File." This file must consist of records with a length of 240 characters or less, with statements 1 or more records long. Statements are delimited with semi-colons. (**NOTE**: a common error is to leave off a ";".) Format of the file depends on the data type, but a typical format for occupancy data is shown in Figure 8-4). The convention of Program Mark is that this input file name ends in the INP suffix. The root part of the file name is then carried on through other files created by MARK to hold model results. For example, the input file AMPHIB.INP would produce a Results File with the name AMPHIB.DBF and two additional files (AMPHIB.FPT and AMPHIB.CDX) that would contain the memo fields and index orderings, respectively.

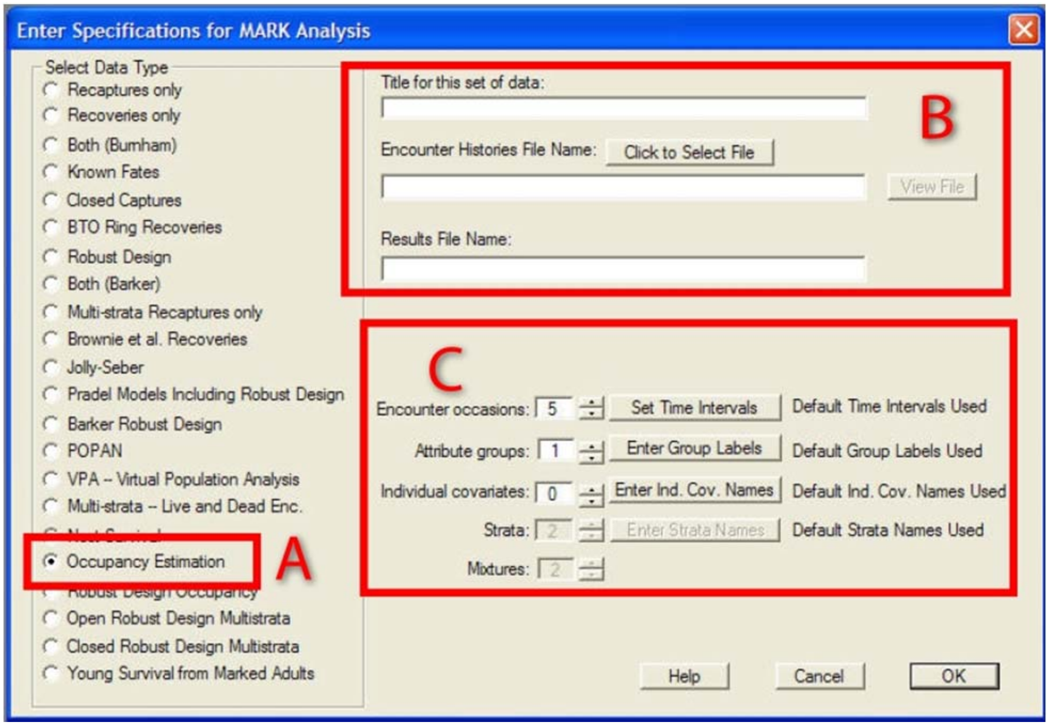


Figure 8-3. The opening page from program MARK for setting up a new analysis. Users should check the data type (A) "Occupancy Estimation" for single season models or "Robust Design Occupancy" data type for multi-season models. The user must also specify file names (B), and model specifications (C) including the number of sampling (encounter) occasions, the number of attribute groups, and the number of site (individual) covariates. Naming of groups and covariates is optional.

	SITE ID		ENCOUNTER HISTORY	GROUPS		COVARIATES	
/*	YELL_PSMS_1317	*/	1 1 1 .	1	0	0.054	;
/*	YELL_PSMS_1318	*/	1 1 0 0	1	0	0.428	;
/*	YELL_PSMS_1319	*/	0 0 1 0	1	0	0.287	;
/*	YELL_PSMS_1320	*/	0 0 1 1	1	0	0.885	;
/*	YELL_PSMS_1321	*/	1 0 0 1	1	0	0.846	;
/*	YELL_PSMS_1322	*/	0 0 0 0	1	0	0.834	;
/*	YELL_PSMS_1323	*/	0 0 0 1	1	0	0.196	;
/*	YELL_RALU_1324	*/	0 0 1 1	0	1	0.596	;
/*	YELL_RALU_1325	*/	1 1 1 1	0	1	0.289	;
/*	YELL_RALU_1326	*/	0 0 1 .	0	1	0.013	;

Figure 8-4. Data input for MARK. Data for each site (rows) and sampling occasion (columns) are represented by: “1” when the species was observed, “0” when the species was not observed, and “.” when the site was not sampled during that sampling occasion. Note that the Site ID is enclosed within the symbols /* */, which indicates that these are user-defined descriptive data. Note also the number of groups and covariates was identified on the entry page, and that each line ends with a semicolon.

Considering Class and Continuous Effects on Occupancy

It is important to distinguish among continuous and class (e.g. categorical or discrete values) variables before moving further. Just as in generalized linear modeling, the approach to analysis varies depending on whether variables are continuous or class. Let’s consider year as an example. If year is a class variable for occupancy, then for a monitoring effort spanning 12 years, we would estimate 12 parameters (one for each year) (Figure 8-5). If our model selection supported this model, we would have evidence that occupancy differed among years, and we could derive an estimate for each year (Figure 8-6), but it would not provide any indication of a pattern or trend in that variation. An alternative approach would be to treat year as linear (or some other) function of a continuous variable (although it is actually discrete, but ordinal). Thus, rather than a separate estimate for each year (12 parameters), we would estimate two parameters, one for the intercept ($ß_0$) and one for the slope ($ß_i$) (Figure 8-7). Other covariates can be treated in a similar manner.

Although we have shown this relationship as a typical regression model for simplicity, it will usually be estimated with an alternative link function. For example, rather than express the relationship in Figure 8-7 as: Occupancy (Ψ_i) = $ß_0 + ß_iX_i$, it would likely be expressed as: logit (Ψ_i) = $ß_0 + ß_iX_i$, to account for the estimates being constrained between 0 and 1 and treat it as we would a logistic regression model. Note the important instruction, excerpted from the Appendix of the PRESENCE help files, about continuous covariates (see http://www.mbr-pwrc.usgs.gov/software/doc/presence/presence.html#covariates):

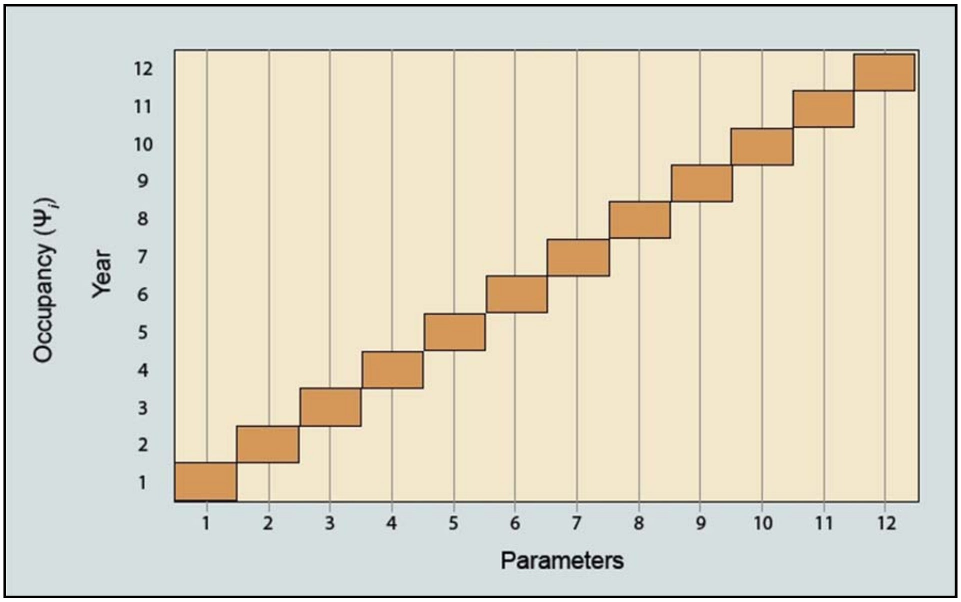


Figure 8-5. Parameter Index Matrix (PIM) chart showing estimated occupancy for each year of a 12-year program if considered as a class variable.

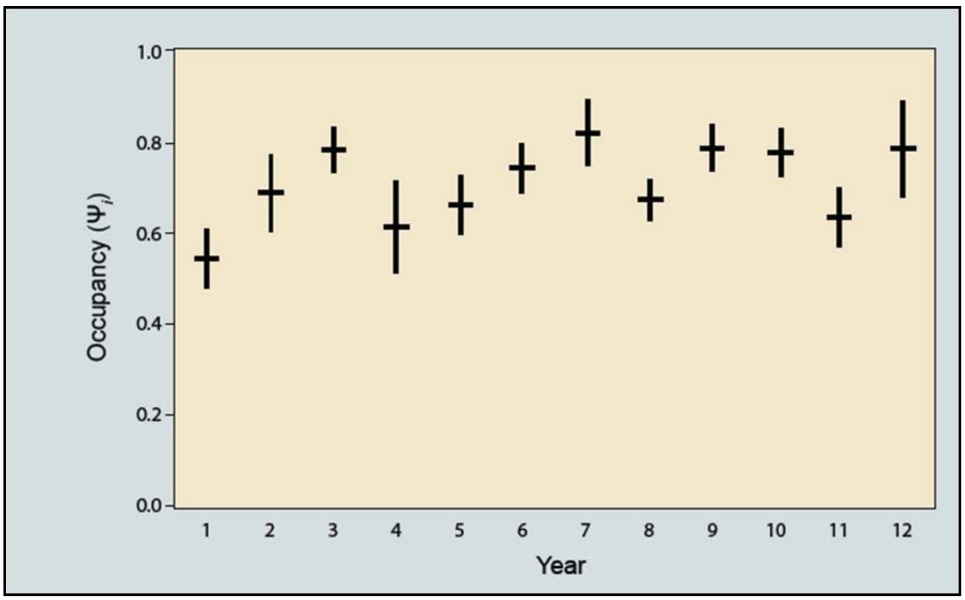


Figure 8-6. Typical depiction of occupancy estimates and standard error estimates over time. Hypothetical estimates of occupancy are plotted with standard errors annually for 12 years. This approach is limited in its analytical ability to elucidate trends.

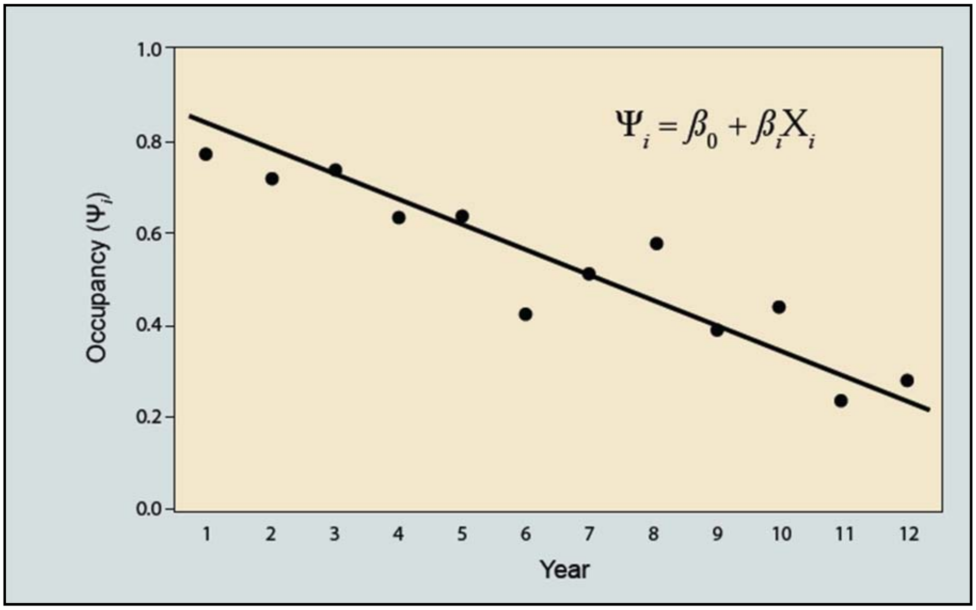


Figure 8-7. Alternative approach for analyzing trends in occupancy over time using regression and hypothetical estimates of occupancy. Using a linear model, two parameters are estimated, an intercept (ß0) and a slope (ß1), rather than the 12 individual estimates of occupancy.

Concluding Remarks

Within this SOP, a description of the approaches and considerations used to quantify patterns of native amphibian occupancy within GRTE and YELL are discussed. This SOP is not intended to be exhaustive or authoritative but instead describe a framework for the application of occupancy modeling for long-term amphibian survey data. Numerous examples describing the application of occupancy modeling for amphibian status and trend monitoring have been published and each describes how monitoring programs are employing occupancy approaches to estimate detection and occupancy probabilities (see Bailey et al. 2004 as an example). In addition, a case study describing the application of occupancy modeling to determine the multi-season presence of native amphibians in the GRTE and YELL (Gould et al. 2012) is included as Appendix E.

We also discuss techniques used to enter data into software programs (PRESENCE and MARK) commonly used to produce occupancy estimates. Other software or programs are currently available (see R ‘unmarked’) and could be employed for calculating detection probabilities and occupancy estimates.

References

Bailey, L. L. and M. J. Adams. 2005. Occupancy models to study wildlife. U.S. Geological Survey Fact Sheet 2005–3096 available at: http://fresc.usgs.gov/products/fs/fs2005-3096.pdf . Corvallis, Oregon. Accessed February 6, 2013.

Bailey, L. L., T. R. Simons, and K. H. Pollock. 2004. Estimating site occupancy and species detection probability parameters for terrestrial salamanders. *Ecology* 14:692-702.

Burnham, K. P. and D. R. Anderson. 2002. Model selection and multimodel inference: A practical information-theoretic approach, Springer-Verlag, New York, New York.

Corn, P. S, M. J. Adams, W. A. Battaglin, A. L. Gallant, D. L. James, M. Knutson, C. A. Langtimm, and J. R. Sauer. 2005a. Amphibian Research and Monitoring Initiative: Concepts and implementation. Scientific Investigations Report 2005-5015. U.S. Geological Survey, Reston, Virginia.

Franken, S. K. 2004. USGS EROS Data Center produces seamless hydrologic derivatives with GIS. ArcNews Online, Fall 2004. Available at: http://www.esri.com/news/arcnews/fall04articles/usgs-eros.html. Accessed January 3, 2013.

Gould, W. R., D. A. Patla, R. Daley, S. P. Corn, B. R. Hossack, R. Bennetts, and C. A. Peterson. 2012. Estimating occupancy in large landscapes: evaluation of amphibian monitoring in the Greater Yellowstone Ecosystem. *Wetlands* 32:379-389.

MacKenzie, D. I., J. D. Nichols, G. B. Lachman, S. Droege, J. A. Royle, and C. A. Langtimm. 2002. Estimating site occupancy rates when detection probabilities are less than one. *Ecology* 83:2248-2255.

MacKenzie, D. I., J. D. Nichols, J. E. Hines, M. G. Knutson, A. B. Franklin. 2003. Estimating site occupancy, colonization, and local extinction when a species is detected imperfectly. *Ecology* 84:2200-2207.

MacKenzie, D. I., J. D. Nichols, J. A. Royle, K. P. Pollock, L. L. Bailey, and J. E. Hines. 2006. Occupancy estimation and modeling: Inferring patterns and dynamics of species occurrence. Academic Press, San Diego, California.

Schmidt, B.R. 2005. Monitoring the distribution of pond-breeding amphibians whens species are detected imperfectly. *Aquatic Conservation: Marine and Freshwater Ecosystems* 15:681-692.

White, G. C. and K. P. Burnham. 1999. Program MARK: Survival estimation from populations of marked animals. Bird Study 46 Supplement:120-138.

Standard Operating Procedure (SOP) 9: Quality Assurance Procedures

Version 1.0, April 2013

Change History

Original Version #	Date of Revision	Revised By	Changes	Justification	Pages Affected	New Version #

Overview

This SOP describes the field season and post-field season quality assurance activities that have been employed successfully by the GRYN Amphibian Monitoring Program to ensure data integrity and limit omissions, entry of erroneous data values, or recording of duplicate records in the GRYN amphibian monitoring database.

Database QA—Field Validation (every two weeks during the field season)

Field Coordinator Duties:

Approximately every two weeks during the field season the field coordinator checks the database using the following procedures:

- Review the written Database Log to see if field crew members have noted any problems with electronic devices (e.g., database synchronization) or their QA checks (see SOP 2: Pre-season Preparations and Equipment Setup).
- Discuss these issues with field crew members and resolve if possible, including corrections to data base records. Difficult problems in database or corrections that require changes to many records may be postponed for resolution during post-season validation. In this case, the problem is described in the Database Log for future reference.
- Query the WetlandSurvey table in the database for the time frame under review (two weeks), and check for the following:
    - Are catchment numbers correct? Any incorrect (e.g., transposed numbers) flags a situation of multiple records in multiple tables to be corrected. Make corrections or record problem for later resolution
    - Do catchments and sites match field log sheets; are there any missing or duplicate sites?
    - Does each surveyed site have both a Primary and Secondary survey record?
    - Are all required fields filled in for these records?
    - Are species records (checked as an inserted subdatasheet) complete and correct, as checked against the field log sheets? (Note: a paper backup of species detected for each species may be maintained, similar to methodology used by ARMI in Glacier NP.)
- Review the Habitat, Weather, and SpeciesData tables for this time frame to ensure that all required fields have been properly and entirely completed.

Post-season Data Validation

After all data are entered, following the end of field season, the field coordinator conducts data validation. This includes:

- Delete test or training records (entered during field crew training or testing of electronic devices).
- Search for, identify, and resolve (or document) data values that are outside the defined, expected, or reasonable limits for each parameter.

— Export spatial data values (coordinates) from the Sites table to a GIS layer showing catchment boundaries; examine the plotted coordinates to determine if any values are incorrect (i.e., outside of catchments that are monitored). Make corrections to the Sites table as necessary.

— Ensure that the relationships between data tables are correct (referential integrity).

— Run the “Search for Orphans” tool; orphaned secondary surveys (no affiliated parent surveys); orphaned weather records (no affiliated surveys); orphaned habitat records (no affiliated surveys); and orphaned surveys (no affiliated sites).

— Identify and resolve blank or missing values in data sets.

— Resolve any discrepancies in site identification with reference to site sketches, site photos, and field crew notes.

— Try to resolve redundant records if any.

— Keep a spreadsheet record of problems encountered and how they were resolved.

Standard Operating Procedure (SOP) 10: Protocol Revision

Version 1.0, April 2013

Change History

Original Version #	Date of Revision	Revised By	Changes	Justification	Pages Affected	New Version #
GRYN V1.0	February 2013	N. Chambers	Editing and formatting	Preparation for publication	All	GRYN V1.0

Overview

This SOP describes procedures necessary to revise the protocol. The protocol narrative, appendices, SOPs, and data sheets are managed to ensure that only authorized and approved modifications are made to these documents and to maintain a complete version history of this protocol to ensure all data can be synthesized, analyzed, and reported.

Procedures

I. Review and if necessary revise the protocol narrative document:

A. Each year, evaluate the monitoring protocol narrative document during field close-out activities and continuing throughout the data analysis and reporting period in order to capture issues that may need attention.

B. If changes are necessary perform all edits in a copy of the original (or latest) protocol narrative document well before the start of the upcoming field season to allow time for internal review and approval of minor changes, and possibly additional, lengthier reviews if there are major changes.

C. Make minor updates to clarify or further describe objectives and/or methods that will help readers and users understand the purpose and methods for monitoring. Consult with the program manager to resolve questions about minor versus major changes. Minor updates are those that do not change the underlying objectives, methods or outputs. For example:

1. Correcting spelling and grammatical errors in existing text.
2. Adding descriptive detail to an existing section to improve clarity and promote understanding.
3. Updating a graphic to better reflect existing methods or outputs.
4. Improving the layout and design of a data collection form for existing (not new) parameters.

D. Record every minor change in the revision history log located at the beginning of the monitoring protocol narrative. Follow the instructions that accompany the log.

E. Consult with the program manger if major adjustments are necessary that involve existing objectives, sample design, parameter values, data management, analytical formulas or procedures, or report content.

F. If approved by the program manager, make the required major updates to the monitoring protocol narrative. Examples of changes that could represent major updates:

1. Changing (as opposed to clarifying) monitoring objective(s).
2. Including additional sampled parameters/variables.
3. Discontinuing existing sampled parameters/variables.
4. Changing the sample population spatially or otherwise.
5. Changing the sampling approach to sample more, less, or differently.
6. Changing the sampling schedule such that the volume and distribution of data in a given time period changes, which could affect the precision or timing of status and trend estimates.
7. Changing the existing method(s) for collecting data in ways that make previously collected data inherently different from data collected using revised methods, for example, increased or decreased precision or a different domain of allowed values for a parameter.

G. Record every major change in the revision history log located at the beginning of the monitoring protocol narrative. Follow the instructions that accompany the log.

H. If changes were made to the protocol narrative document, update the version number and the current date at the beginning of the document and everywhere else the version number and/or date are used, e.g. in document headers or footers. Use the next sequential tenth of an integer only if all of the changes were minor (i.e., Version 1.0 changes to 1.1). Use the next whole integer with zero in the tenths place if one or more major changes were made (i.e., Version 1.3 changes to 2.0).

I. Save the updated document, with the latest version number in the file name, in the project's protocol folder on the GRYN server.

II. Review and if necessary revise Standard Operating Procedure (SOP) documents:

A. Evaluate every SOP associated with the monitoring protocol each year, in conjunction with the evaluation and possible update of the protocol narrative. If the protocol narrative received a major revision then one or more SOPs must also receive a major revision that reflects the new information in the narrative. If the protocol narrative was not changed or changed only in minor ways that aren't directly linked to SOP content, then it may not be necessary to revise SOPs. In general, however, SOPs are revised more frequently (often annually) than the protocol narrative.

B. Perform all SOP edits in a copy of the original (or latest) version of the SOP document.

C. Use lessons learned and latest information from the most recent survey period to make SOPs more helpful to future users.

D. Incorporate instructions for new equipment such as cameras and GPS devices, and to reflect improvements in data collection systems and tools.

E. Assign a new version number to the front page of each changed SOP, along with the current date. Use the next sequential tenth of an integer only if all of the changes were minor. Use the next whole integer with zero in the tenths place if one or more major changes were made. In general, if a major change occurs to one or more SOPs then the protocol narrative receives a corresponding major revision. Remember to communicate and coordinate all major revisions in SOPs and the protocol narrative with the program manager.

F. Record all changes in the revision history log located at the beginning of the SOP. Follow the instructions that accompany the log for updating the version number. If there are none described follow the guidance for updating the narrative version number described above.

G. Save the updated document, with the latest version number in the file name, in the project's protocol folder on the GRYN server.

III. Share updates and archive previous versions:

A. Archive previous versions of the narrative and each SOP on the GRYN server in the archive folder under the project's protocol folder.

B. If major revisions require additional peer-review and/or approval, the program manager coordinates this with the regional I&M program manager.

C. Update the Master Version Table (MVT) (Table SOP 10-1) by keeping track of current and historic versions of the protocol narrative and Standard Operating Procedures (SOPs), associated with the monitoring protocol.

D. Update records and content in the NPS online resource information database.

E. Inform users of the monitoring protocol about updates, and provide instructions on how to reach the updates online.

Table 10-1. Master Version Table.

Version Key #	Date of Change	Narrative	SOP #1	SOP #2	SOP #3	SOP #4	SOP #5	SOP #6	SOP #7	SOP #8
VK1										
VK2										
VK3										

NPS 960/120502, April 2013

National Park Service
U.S. Department of the Interior

Natural Resource Stewardship and Science

Natural Resource Stewardship and Science
1201 Oakridge Drive, Suite 150
Fort Collins, CO 80525

www.nature.nps.gov