Secondary Data Quality Assurance Project Plan for the Development and Initial Deployment and Testing of the BORIIS2 Biodiversity Database v6 (May 2024)

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0.2 TABLE OF CONTENTS

0.3 Abbreviations:

BORIIS	Biota of Rhode Island Information System
BUG	BORIIS User Group
EPA	United States Environmental Protection Agency
FGDC	Federal Geographic Data Committee
NBEP	Narragansett Bay Estuary Program
QAPP	Quality Assurance Project Plan
QAQC	Quality Assurance Quality Control
RICSC	Rhode Island Conservation Stewardship Collaborative
RIDEM	Rhode Island Department of Environmental Management
RIGIS	Rhode Island Geographic Information System
RINHS	Rhode Island Natural History Survey
TNC	The Nature Conservancy, Rhode Island office
URI	University of Rhode Island

0.4 Distribution List

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1.0 BACKGROUND AND SUMMARY OF OPERATION

The Rhode Island Natural History Survey ("the Survey"), a member-supported 501c3 nonprofit, gathers information on observations of species of animal, plant, fungi, and other life, and natural communities in Rhode Island from a range of sources including among others, scientists, educators and students, government agency and NGO personnel, the general public, published and unpublished written sources, and museum collections.

Using digital databases, and other tools when appropriate, the Survey carefully preserves observations and associated metadata or supporting information and undertakes reasonable measures to confirm them and/or understand their limitations.

The Survey makes information on species and natural communities in Rhode Island, or reports based on that information, available for a variety of purposes to a broad range of audiences including among others, scientists, land conservation entities, government agencies, and educators and students. Users consult the Survey for information for a wide range of purposes including education, personal interest/entertainment, research, or to inform management and policy.

In collecting, preserving, and distributing these data, the Survey works to protect sources and the data themselves from loss, adulteration, or public exposure where such exposure endangers the organism(s) or data source.

To store, organize, and distribute biodiversity observations, along with information on their source(s), the Survey uses a variety of means including public events, a reference library and archive, semi-annual bulletin, and a computerized data management system or relational database it calls the Biota of Rhode Island Information System (BORIIS).

As originally developed in 2004, BORIIS consisted of several Microsoft Access databases coordinated through a single front end. BORIIS incorporated some 110,000 lines of data from: the Survey's previous internal (FileMaker Pro-based) database; the Odonata Atlas of RI, Beetles of RI, and Mycota of RI projects; the legacy RI Natural Heritage Program database; and substantial data-mining within published and unpublished written sources, photographs, and museum specimens. BORIIS is not suitable to present needs, and the Survey has been planning a successor, referred to as BORIIS2, for a number of years.

As they are acquired by the Survey, observations and other data are of variable quality and some information is suited for certain uses and not others. Because BORIIS2 is primarily an indexical resource, and because there are so many possible combinations of information sources and information users, it is essential that connections between information and its sources be retained. This allows suitable filters to be employed by, and suitable limitations expressed to users/recipients. Depending on users' requirements, this also assists users to use BORIIS2 as an index to identify the source(s) of relevant data and consult those data in the original.

BORIIS2 is envisioned to take two years to fully roll out and become operational (see 2.7 timeline). Feedback from a formal stakeholder group and from the general public will be

continuous during and after roll-out. Engineering capacity and adaptive management in operations will be required for the first two years. BORIIS2 is envisioned to have a useful life of at least 10 years before significant overhaul.

Survey data management operations, digital and otherwise, are carried out by Survey staff with the guidance and input of the Survey Board of Directors and a formal stakeholder user group. Access to BORIIS2, for any user, either for entry or retrieval of information, at least initially, is carried out by the Survey's Data Clerk or other appropriately trained staff (see 7.2.1), which may in certain circumstances include trained volunteers supervised by the Data Clerk. Certain levels of secure direct access for appropriate users are desirable in the future but were not prioritized in early discussions with stakeholders and are not part of this present plan.

This is the Secondary Data Quality Assurance Project Plan (QAPP) for the development and initial deployment and testing of a working prototype of a new edition of BORIIS known as BORIIS2. As BORIIS2 stores and allows access to already-existing data, this document is a Secondary Data QAPP. Data collection activities provisioning BORIIS2 may be subject to their own QAPPs (see below).

2.0 SHORT SUMMARY DESCRIPTION OF BORIIS2

2.1 *What is it:*

A relational database, operating procedures, and suitable user access mechanisms to index observations of species in Rhode Island from a variety of original sources allowing appropriate users to access basic information and get assistance finding original sources in ways that advance research, education, and conservation in Rhode Island. A successor to a predecessor database known as Biota of Rhode Island Information System (BORIIS).

2.2 *Primary Purpose:*

Provide a data facility to support the study and management of biodiversity (including rare species) in Rhode Island.

2.3 *Secondary Purposes:*

Provide a data facility to support:

- management of invasive species or other categories of species (e.g. species of research interest)
- inventories and surveys, especially distributed, community science-type projects
- communication and collaboration with neighboring and regional states and tribal entities with regard to biodiversity conservation targets and environmental management priorities
- connecting users with information on Rhode Island specimens in far-flung, hard-to-access collections
- compiling biographical information on naturalists who have worked in Rhode Island
- compiling bibliography of publications on Rhode Island natural history

2.4 *Primary User:*
Internal use of the Natural History Survey staff (including volunteers) to index species observations (particularly of rare species) coming to attention through a range of sources; and to provide static output to partners who request it, including the Rhode Island Department of Environmental Management.

2.5 *Secondary Users:*
- staff in partner organizations, including government agencies and nonprofits, who can access information on the location and viability of species, primarily in Rhode Island.
- others needing data for management of species, primarily in Rhode Island but also in neighboring states and areas.
- a broadly constituted user group, created in 2023, meeting approximately quarterly, discusses use cases, priority data, and access timeliness; and these discussions have guided the development of the plan and are reflected in this QAPP.
- [**future**] support an online tool allowing the public to access appropriate data (i.e. what species live in their town, whether anyone's ever seen a certain species in RI before, etc.)

2.6 *Main attributes:*
- **Indexical**...data are brought into BORIIS2 to answer the "who, what, when, where" questions and identify the source(s) of the information. For the most exacting uses, users are encouraged to follow citations in BORIIS2 back to original sources.
- Takes the greatest advantage possible of existing data to populate tables consistent with reasonable steps to systematically vet data transferred into BORIIS2.
- Most operations can be done with minimal special training; requires minimal (or no) ongoing work by specialist database technicians.
- Transparent in structure and operation and fully documented to ease uptake, use, maintenance, iteration
- QA built in as much as possible with auto-complete, dynamic searches, drop-down menus, and pre-packaged QC queries, etc.
- Metadata compatible with national/international standards
- Rare species locales, landowner identification, and other sensitive data can be segregated/obscured under certain specified circumstances
- Fields and formats are consistent with standard practice outside Rhode Island (e.g. Massachusetts, NatureServe, GBIF) to ease data sharing and communication regionally

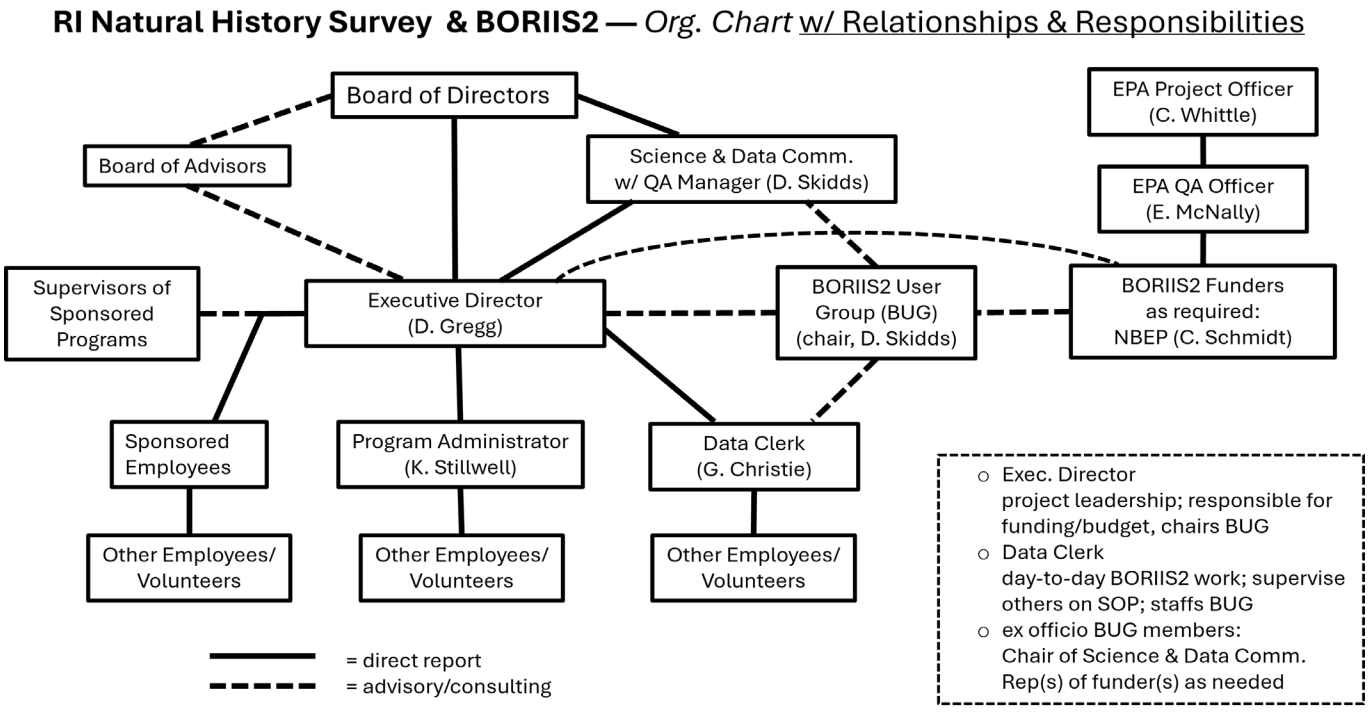
2.7 *Timeline:*

- October 2023 NBEP funding commences
- January 2024 Solicit and review contractors via RFQ; begin to prepare QAPP; BUG meeting
  Deliverables: RFQ
- March 2024 Contractors respond with proposals
- April 2024 Contractors reviewed, contract negotiations
- May 2024 QAPP approval; contractor contracted; BUG meeting
  Deliverables: QAPP; contract
- June/July 2024 Phase 1-Discovery w/ contractor
  Deliverables: Discovery package; Phase 2-Build plan and firm cost
- Summer 2024 Build, test, debug
  Begin "Establishment phase 1" (see 6.1)
  Deliverables: Beta prototype (draft); installation of core data
- Fall 2024 Roll-out to BUG with testing and feedback; BUG meeting
  Begin "Establishment phase 2" (see 6.2)
  Deliverables: Finished prototype database; Documentation/metadata
  Deliverables: Plan for next phase of BORIIS2 development; invoicing; report
- 2025 Additional data input, historical sources and voucher collections; BUG meetings
  Begin "Operations" (see 8.0)
- September 30, 2025 Subaward ends
- December 31, 2025 This secondary QAPP expires
- 2025-2026 Public roll-out with forums and feedback; Additional user feedback
- 2026 Additional engineering/adaptive management; seek funding; new QAPP
- Useful life of 10 years before major overhaul, roughly 2024-2034.

3.0 PROJECT MANAGEMENT – ORGANIZATION AND RESPONSIBILITIES

3.1 *Rhode Island Natural History Survey*: The BORIIS2 project is conceived, organized, and carried out by the Rhode Island Natural History Survey (the Survey). The Survey is a member-supported 501c3 nonprofit founded in 1994 with a mission to encourage public participation in environmental science and the use of science to solve environmental problems. It manages data documenting the state's species and natural communities, publishes books and articles, facilitates projects that have diverse partners or complex funding, and hosts events bringing people together including conferences and the annual Rhode Island BioBlitz. It has staff of 4.5 Full Time Equivalents including full time Executive Director, Program Administrator, and two project scientists and a part time Data Clerk, in addition to volunteers. It is governed by a volunteer Board of Directors drawn from across a broad range of community stakeholders.

The Executive Director reports to the Board of Directors and manages Survey activities and is also the Survey's Principal Investigator for the BORIIS2 project. The Data Clerk is responsible for day-to-day operation of the predecessors to BORIIS2 and many specific details of BORIIS2 development and will be responsible for day-to-day operation of BORIIS2. The Data Clerk reports to the Executive Director. The Board of Directors has a standing committee called the Science and Data Committee which specifically advises the Executive Director on scientific and data activities and reviews the scientific rigor of the Survey's scientific products and data management activities (see Figure 1). See 3.3 below for the role of the BORIIS2 User Group (aka "BUG"). Funding, for example from the United States Environmental Protection Agency (EPA), through the Narragansett Bay Estuary Program (NBEP) and their fiscal agent, Roger Williams University (RWU) (see 3.4 below), may require certain things, and this can, depending on the circumstances, be facilitated in different ways, for example by including a representative in an *ex officio* position on the BUG.



1 Survey Org. Chart w/ BORIIS2 Relationships and Responsibilities

Survey Executive Director and BORIIS2 Principal Investigator
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Project Quality Assurance Manager
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Robert D. Kenney, Ph.D., Assoc. Research Scientist, URI Graduate School of Oceanography
Hugh Markey, retired teacher
Brian Oakley, Ph.D., Professor, Assoc. Prof., Envir. & Earth Sci., E. Connecticut State Univ.

Survey Program Administrator and Project Administrative and Financial Contact
Kira Stillwell,
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401-874-5800

3.2 *Primary and Secondary Users*:
The primary user of BORIIS2 is the Natural History Survey staff (including volunteers). The expressed use case is to index species observations (particularly of rare species), and store information on species location and viability coming to Survey attention through a range of sources in order to answer questions internal to the Survey, guide prioritization of programs and projects and inform positions the Survey is called on to articulate during its participation in other stakeholders' committees and projects.

As the Survey's internal database, BORIIS2 is intended to be used by the Survey to provide information to parties external to the Survey, for example staff in partner organizations, including government agencies and nonprofits, to answer questions about the locations of species, particularly species listed as rare by the State, and their viability, guide actions and policies, stimulate fieldwork and education, and inform research as well as to be a source for various forms of static output (maps, lists, reports) to partners who request it, including the Rhode Island Department of Environmental Management.

Secondary BORIIS2 users are envisioned to have diverse purposes in the general areas of education, personal enrichment/entertainment, research, and to inform management and policy, among others, and concomitantly diverse data needs with a wide range of tolerance for

uncertainty. Generally speaking, BORIIS2 users are responsible for selecting data that meets their needs, and BORIIS2 is designed and operated in a way that supports their ability to do that.

BORIIS2 could also facilitate/improve Rhode Island participation, via the Survey or another stakeholder, in regional and national initiatives, for example the NatureServe network, Northeast Regional Invasive Species & Climate Change (RISCC) Management Network, or the Native Plant Trust's New England Plant Conservation Program (NEPCoP).

3.3 *BORIIS2 User Group (BUG)*: It is essential that BORIIS2 develop, and eventually operate, in cognizance of user needs and expectations. To this end, in 2023, the Survey instituted a stakeholder group called the BORIIS2 User Group (BUG) to guide the BORIIS2 development. Its membership includes the Principal Investigator and Data Clerk, the Chair of the Survey Board's Science and Data Committee, representatives of the Narragansett Bay Estuary Program as both a potential data user and project funder, parties to the 2012 Heritage Database MOU (see 3.5), and representatives of other conservation organizations, natural resource agencies, academics, and private environmental consultancy businesses. The BUG in its own right does not provide data to or use data from BORIIS2, though its members may well in the pursuit of their singular activities.

The BUG has met roughly quarterly since the beginning of calendar 2023 to review progress and advise on key decisions. In this time, BUG meetings have included discussion of the historical trajectory of Rhode Island biodiversity data management to this point, the expectations for update cycles, outputs, and access, data security, georeferencing practices, and typical usage, among other topics. Agendas, handouts, and minutes/notes are circulated.

The intent is that the BUG will transition into a steering committee for the data operation once BORIIS2 is operational. At that time, the kinds of things the BUG could be asked to consult on include the following, about many of which further details are provided later in this document:

- its own membership
- technical specifications and decisions regarding hardware and software
- BORIIS2 data model (see 4.0)
    - data qualification flow and criteria
    - QAQC criteria and procedures
- taxonomic authorities (see 4.2)
- priorities and features for future development, including spatial module (see 4.4.1)
- position description of data clerk or other staff (see 7.2)
- contents of the operations manual (see 7.4)
- data security and privacy screening and safeguards criteria (see 7.5)
- data request assessment model and criteria (see 8.0)
- future access and use ideas and ideas for funding

Ultimately, responsibility for the BORIIS2 project lies with the Survey's Board of Directors, to whom the BORIIS2 Principal Investigator reports, and the BUG is advisory. Nonetheless, responsiveness by project staff is encouraged by the inclusion of both the Science and Data Committee Chair and funders' representatives on the committee.

The makeup of the BUG as of this date is:

LAST	FIRST	AFFILIATION	EMAIL
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Doherty	Marc	Westerly Land Trust	mdoherty@westerlylandtrust.org
Ernst	Nick	USFWS	nick_ernst@fws.gov
Floyd	Chris	URI NRS	floydch@uri.edu
Freitas	Amanda	RINHS/RIDEM	Amanda.Freitas@dem.ri.gov
Gregg	David	RINHS (chair)	dgregg@rinhs.org
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Labash	Chuck	URI-EDC	labashc@uri.edu
Mitchell	Jon	Narr Bay NERR	jonathan.mitchell@dem.ri.gov
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Schmidt	Courtney	NBEP	courtney.schmidt@nbep.org
Sorlien	Mariel	NBEP	msorlien@nbep.org

3.4 *Narragansett Bay Estuary Program and Roger Williams University*:
The allocation of funds by the Narragansett Bay Estuary Program (NBEP) to the BORIIS2 project is the responsibility of NBEP's Executive Director, and they are administered by NBEP's Pass Through Entity, Roger Williams University (RWU).

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NBEP's Project Officer will keep EPA informed of milestones, deliverables, shortcomings, and corrective actions as she becomes aware of them and Rhode Island Natural History Survey is responsible for keeping NBEP informed about the progress measures specified in this document. The Survey will inform NBEP when a contractor is selected, and NBEP will inform EPA.

3.5 *Rhode Island Natural Heritage Program/RI Department of Environmental Management*: The Rhode Island Natural Heritage Program was created by the Rhode Island Department of Environmental Management (RIDEM) in 1978 under authority of RI General Law 20.37.2. Until 2002, data on species were gathered and curated and decisions about listing criteria and species' listing status were made by RIDEM with assistance of the Rhode Island office of The Nature Conservancy (TNC). In 2002, a three-way Memorandum of Understanding (MOU) was signed by RIDEM, TNC, and the Survey giving the Survey responsibility for managing rare species data in the state. In 2012, a similar MOU was signed by the same parties adding the University of Rhode Island and making the four parties into a steering committee for rare species data management being performed by the Survey. The Survey continues to manage rare species data for Rhode Island under the procedures laid out in the 2012 MOU using funding from the Survey and the RI Conservation Stewardship Collaborative Endowment (RICSC). Though it manages data for what is known as the Natural Heritage Program, the Survey does not have any regulatory authority or authority to review or change the listing status of species in the state, that authority remains with RIDEM. RIDEM has expressed interest in continuing to receive Heritage data updates from the Survey after BORIIS2 replaces the current system, and has four staff members participating in the BUG.

3.6 *Quality Assurance Project Plan (Secondary Data)*: This is the Secondary Data Quality Assurance Project Plan (QAPP) for the development and initial deployment and testing of a working prototype of BORIIS2. As BORIIS2 stores and allows access to already-existing data, this document is a Secondary Data QAPP. Activities collecting data destined for BORIIS2 may be subject to their own QAPPs, and fields suitable for recording that situation are included in the BORIIS2 Data Model.

The QA Manager will review the penultimate and final product for QAPP compliance and make a report to the Science and Data Committee with copies to the Principal Investigator/Executive Director and Narragansett Bay Estuary Program Officer after any review.

If any shortcoming come to his/her attention during a review, or at any other time, the QA Manager can, on his/her own or in consultation with the Science and Data Committee, request corrective actions. The request would be in the form of a written notice (which can include email) addressed to the Principal Investigator with copies to the Science and Data Committee

and Narragansett Bay Estuary Program Officer. The Principal Investigator can address corrective actions to Survey staff, or to the contractor at any time prior to final acceptance of the product (or later if the contract specifies a warrantee period, but that circumstance is not known at this time). Corrective actions are to be verified by the party requesting them and documented with a written notice sent to the same parties that received the original corrective action notice.

In addition or in place of any of the language contained here, NBEP may implement, at its discretion, various reviews of this project to assess conformance and compliance to the Quality Assurance Project Plan. NBEP may issue a stop work order and require corrective action(s) if nonconformance or noncompliance to the Quality Assurance Project Plan is found.

As provided for above herein or as directed by EPA, the Survey, including QA Manager, working closely with NBEP's Project Manager, will update the QAPP as key decisions not made yet as of the date of this QAPP are finalized. The end date of this QAPP is December 31, 2025, but may be modified or extended as allowed by EPA before that time. (see Timeline 2.7)

3.7 *Risks and Resource Constraints:*

3.7.1 *Development and Establishment*— The BORIIS2 development path has been planned conservatively to minimize risk. Looking at BORIIS1, we know that such a relational database can be constructed. The BORIIS2 data model has been developed in increments by the Survey over the past 5 years. The data model has been tested and reviewed in MS Access by Survey staff and the Science and Data Committee as well as contacts in the IT field and consultants hired through UpWork. The unanimous consensus is that it is feasible and appears likely to meet the specified needs. Rough estimates of cost for a working prototype and subsequent phase(s) have been borne out by recent contacts with potential contractors.

Speaking generally, database development can take place at such a wide range of scales that it is hard to be specific about potential costs and resource constraints. To manage this uncertainty, here the strategy has been to lay the project out in phases, with a working prototype or Minimum Viable Product (MVP) loaded with a constrained range of the highest quality data as the first phase and data additions and add-on modules increasing functionalities in the future as resources allow.

Other than time constraints inherent to particular funding sources, there are no time constraints on BORIIS2 development. The Survey's present biodiversity data solutions remain ongoing and workable on a 2- to 3-year time horizon.

3.7.2 *Ongoing operations*— The Survey currently funds its data operations with annual grants of approximately $18,000 from the RI Conservation Stewardship Collaborative (RICSC), and the RICSC has expressed a commitment to continue to provide regular,

predictable funding for database operations at the Survey. The RICSC is a consortium of conservation groups working in Rhode Island which steward or are concerned with the stewardship of conservation land. In addition to the Natural History Survey, the RICSC members are: The Nature Conservancy, University of Rhode Island College of the Environment and Life Sciences, RI Land Trust Council, Audubon Society of RI, US Fish & Wildlife Service, and the RI Department of Environmental Management.

The RICSC meets 2-3 times a year to review obstacles to conservation land stewardship and recommend disbursements of funds from the RICSC Endowment Fund to tackle those obstacles. The RICSC's endowment is managed by the Rhode Island Foundation; it contains approximately $2 million and funds grants totaling approximately $100,000 per year, which includes the Survey's data grant.

Potential contractors were asked as part of their proposals to estimate future recurring costs for software, data storage, and maintenance given their proposed database strategy. We can say, based on that, that with the buildout of BORIIS2, there will be annual running costs of between $2,000 and $17,000 above the Survey's current costs. We can also say, however, that the likely cost is nearer the lower end of that range and as such would be manageable within the scale of the Survey's overall budget (~$600,000/year), at least in the short term. Ultimately, we are counting on the increased functionality provided by BORIIS2 to attract additional baseline funding as well as funded projects over time.

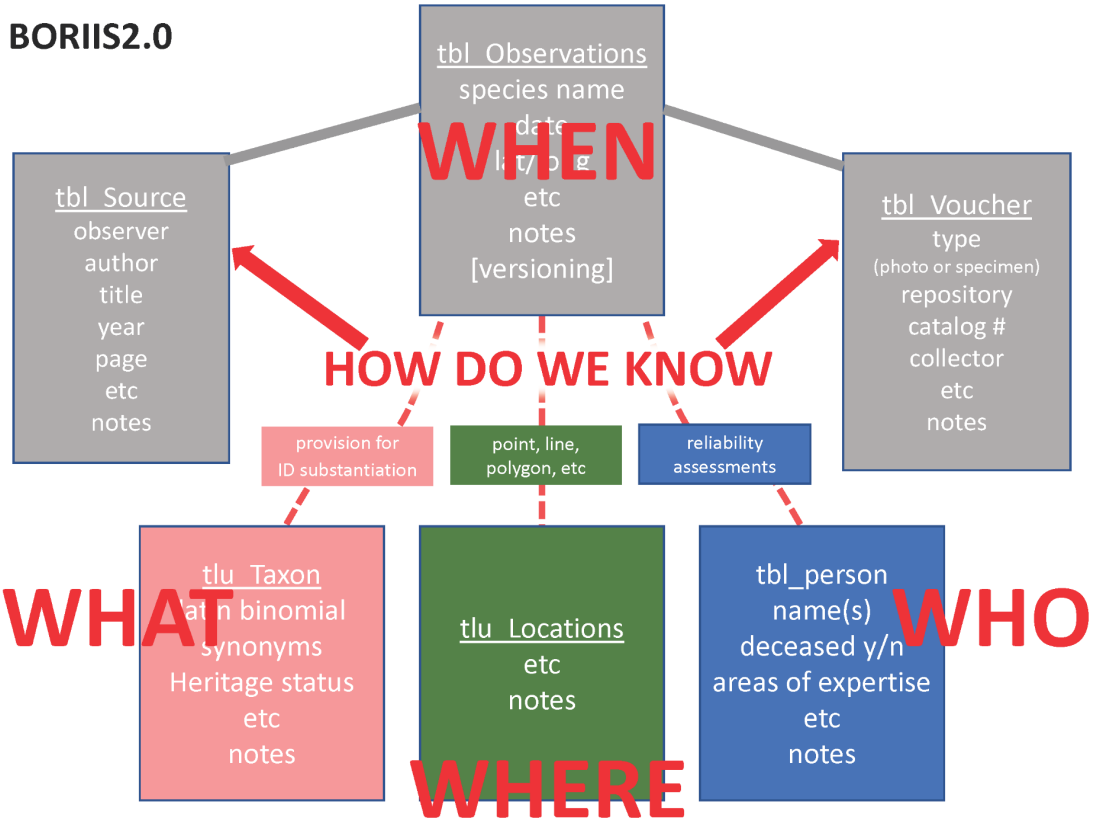
4.0 DATA CHARACTERISTICS AND BORIIS2 DATA MODEL

In BORIIS2, the main object of management consists of the "Observation." An Observation is a unique combination of observer, taxonomically identified organism (usually a species and sometimes referred to as an "Element"), date, and location. Because BORIIS2 is conceived primarily as an index, every Observation requires at least one Evidentiary Record, either a written source or a voucher, which may be either a specimen or a photograph, and these are the original, primary source(s) that BORIIS2 indexes.

Observations are typically submitted to the Survey by others but may also result from Survey activities. To the extent any such primary data gathering activity being indexed by BORIIS2 is

required to have a QAPP, the expectation is that one would be prepared as part of that separate process. Any resulting Observations can be associated with relevant QAPPs using the Source table in BORIIS2 (see 4.5 below).

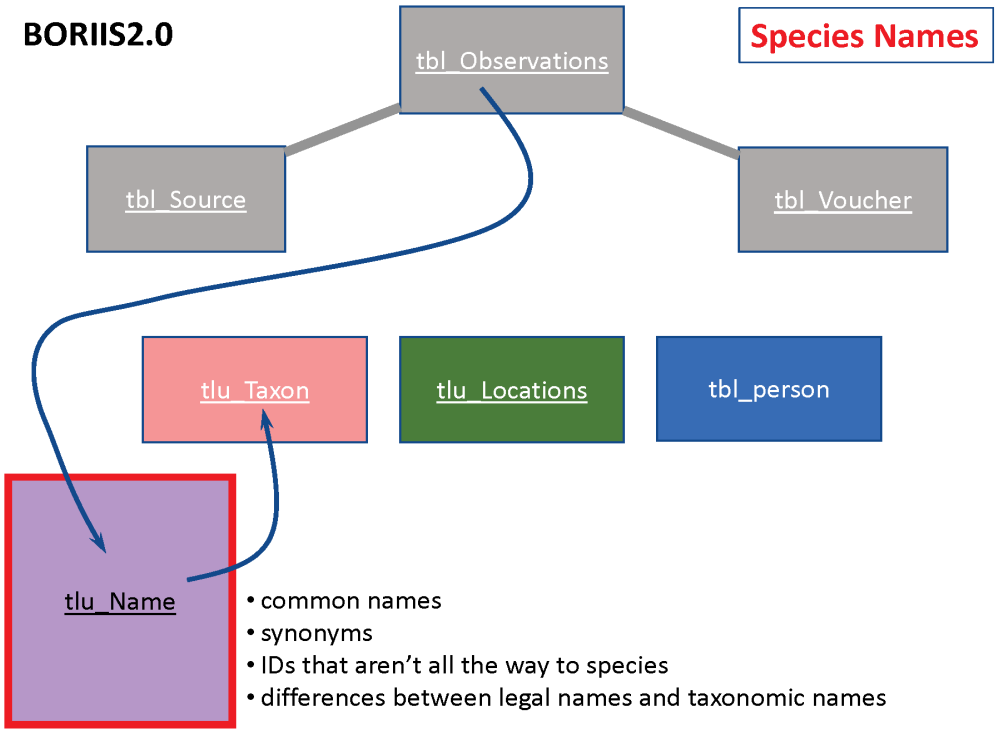
In BORIIS2, an Observation may be summarized as WHO, WHAT, WHEN, WHERE, and HOW DO WE KNOW? (see Figure 2)



2 BORIIS2 data model

4.1 *WHO*: Observers are the actual observer who made the association of element, place, and time, and this may be a different person from the reporter or correspondent who brought the Observation to the Survey's attention. In BORIIS2, all persons' names are recorded in a table with provisions for alternate forms or changed names (Mrs. John Doe vs Jane Doe, C. Everett Koop vs Charles E. Koop, John Smith and Jane Jones vs John and Jane Smith-Jones).

4.2 *WHAT*: Taxonomic labeling of an Observation is handled with two tables (see Figure 3). The observer's verbatim identification of the element is recorded in a Name table (tlu_Name) that handles common names, synonymous binomials, and organisms identified to a higher taxonomic position than species in addition to the accepted names. All names are linked to their accepted taxonomic identities in the Taxon table (tlu_Taxon) which contains one scientific binomial (with provision for varieties and sub-species) for each organism with an Observation in Rhode Island.



3 How the data model handles taxonomy and nomenclature

Unlike familiar hemispheric or global biodiversity cataloging efforts such as GBIF or Encyclopedia of Life, there is no universal, comprehensive taxonomic and nomenclatural authority for BORIIS2. Taxonomic and nomenclatural authorities vary from taxon to taxon. The authority selected for any particular taxon is selected after consultation with appropriate subject matter experts and is based on specialist and common acceptance, present or historic relevance for Rhode Island or the region, and availability of linked identification resources. They are reviewed by the BUG. Examples include the vascular plants, which use the Native Plant Trust's Tracheophyte Checklist and linked

GoBotany key and online resource, and the moths, which use the Checklist of the Lepidoptera of America North of Mexico, tied to the Moth Photographers' Group online resource. Upon roll-out, citations to the taxonomic and nomenclatural authorities for BORIIS2 will be available to the public through the Survey's website.

In an Observation, identification of the species (Element) observed is one of the most important components of data quality and one of the most likely places for error. Evaluation of the identification of the Observed Element is part of Standard Operating Procedure for evaluating any incoming Observation (see 7.0 BORIIS2 Operations). The Survey makes reasonable efforts to screen, verify, or qualify the Element identification in Observations, and these efforts may include further communication with the observer, communication with a subject matter expert, consultation with published or online sources, or arranging for a field site to be revisited.

Verification is also built into the BORIIS2 design. One data field records the observer's uncertainty as to the identification and one field records the Data Clerk's uncertainty as to the observer's identification as to species. Where there is uncertainty, data can also be entered using whichever higher order taxonomic identification actually is certain: i.e. Genus instead of species, Family instead of Genus, or Order instead of Family).

It is essential to bear in mind that there are practical limits to the Survey's ability to verify Observation identifications. Ultimately, BORIIS2 is indexical, intended to organize and characterize data and to point users toward primary sources when additional investigation is needed. Users requiring the highest degrees of certainty should consult the original evidentiary record or make their own field observations.

4.3 *WHEN*: The date of an Observation may be recorded as a single date or, for untended traps, etc., as a date range via an Event table. To facilitate later database operations, dates are recorded as a verbatim date as well as with day, month, and year in separate fields.

In BORIIS2, the smallest searchable temporal unit is one calendar day, though for any particular Observation, a narrower, more specific time could be recorded in one of the Note (open text) fields provided. Not every Observation will be able to be attributed to a single day, however, and this is why the Event field is needed. For example, the specimens from a malaise trap that was open for five days can only be associated with an Event that has a five-day date range.

4.4 *WHERE*: Location is an important attribute for the BORIIS2 use cases: a) to resurvey Observations in the field, or b) to map observations for landscape scale analyses prioritizing conservation actions or policies or screening for regulatory applicability. These are uses being served by the current Heritage data table.

Preferably, the location of an Observation is reported as latitude and longitude coordinates, but it is acceptable for location information to be reported in one of a range of methods and systems. In addition to recording the verbatim location, provision is made in BORIIS2 for

accepting commonly used reporting conventions or converting a reported location to a point, line, or polygon as appropriate using a standardized process (while recording how that conversion was done and by whom in appropriate data fields provided for this purpose). A Location table allows observations to be associated with lines and polygons or with centroids of polygons as appropriate given the source.

For example, an Observation reported by the observer with latitude and longitude would be recorded as is. If the observer describes the means he/she used to acquire the coordinates there is provision in the table structure for that information to be recorded. If the observer reports the observation by parcel or site name, Survey personnel could relate the observation to the corresponding polygon in the Location table. In this case, that location could be represented later as a polygon or centroid. Latitude and longitude for every street address in Rhode Island is available through Rhode Island Emergency Management Agency (RIEMA), and if Observations are reported by street address, they would be associated with the latitude and longitude using the RIEMA data and the particulars of the conversion recorded in the appropriate BORIIS2 fields. If the observer reports location via narrative description using landmarks or walking directions, Survey personnel may use desktop resources such as RIGIS, ArcGIS Online, or Google Earth to derive a latitude and longitude based on that narrative, and in that case the particulars of the derivation would be recorded. In all cases, users can view how Location was determined and is represented and can filter out Location representations that do not meet their needs.

According to stakeholder communications, the BORIIS use cases require accuracy and precision of location information on the scale of a quarter acre to an acre which would be a radius of no less than approximately 17 meters. For its activities, the Survey uses the WGS84 datum and prefers degrees and decimal degrees and for BORIIS will convert locations not received in that format while putting the verbatim coordinates into the Location_Notes field. Typically, Observation Location would be recorded verbatim (the coordinates as they are provided) but in cases may be rounded off in decimal degrees at four places to the right of the decimal (a radius of about 10m in latitude or in longitude).

4.4.1 *Spatial Module*: Locating Observations in space relative to other Observations and other spatial features is an important function of BORIIS2. A substantial amount of what could be incorporated into BORIIS2 is in the form of lines and polygons. The BORIIS2 model needs to be able to store these and relate Observations to each other and to named or otherwise specified Locations. As we know from BUG conversations, geographic projection of Observations (by species, date, observer, etc.) is a common output need, whether for an end-user or for QAQC tasks. It is envisioned, therefore, that BORIIS2 will eventually have a capability for storing and manipulating points, lines, and polygons.

BORIIS1 did not have any spatial analysis capability and worked almost entirely with point locations. If spatial analysis was needed, spatial information was ported from BORIIS1 to a separate ESRI ArcGIS geodatabase. Since it stopped being used within the BORIIS1 environment, Heritage data has been associated with points, in the form of

latitude and longitude, and any needed analysis carried out in Google Earth Pro after importing whatever are the relevant data. A solution for providing spatial analysis capability in BORIIS2 is highly technical and not finalized and is not part of the present prototype development project. The specification being shared with contractors requests they make suggestions as to how they might approach this requirement in the future.

4.5 *HOW DO WE KNOW*?

Because BORIIS2 is fundamentally an index to other sources, in order to be entered into BORIIS2, observations must be substantiated with at least one *Evidentiary Record*: either a Source, which is a published or unpublished written document, or a voucher, which can be either a specimen or a photograph. Both sources and vouchers have their own tables and ancillary structure in BORIIS2. Sources can be published books or articles that report on a species present at a certain time and place or can be unpublished works including dissertations and theses, reports, correspondence, including email, and fieldbooks or other manuscript documents. Vouchers can be whole specimens or less than whole specimens, e.g. skeletons, microscope slides, or tissue samples, in addition to photographs in the form of prints, slides, or digital files. Sources such as letters with enclosed photographs would constitute two evidentiary records, one of each type. Published and unpublished printed sources would be incorporated with typical bibliographic citations allowing users to find them for consultation. Unpublished manuscript material and vouchers would be associated with appropriate repository information, at minimum the name of repository and relevant cataloging information.

For BORIIS2, the author of the Source or the donor of a Voucher are not necessarily recorded as the Observer. If known to be different from the author or donor, it is important that the name of the person who made the first-hand observation or collection in the field is recorded in BORIIS2 using the Person table while the verbatim author or collector name is recorded separately (this may not be possible in all cases, in which case the author or collection donor would be given instead with a note to that effect).

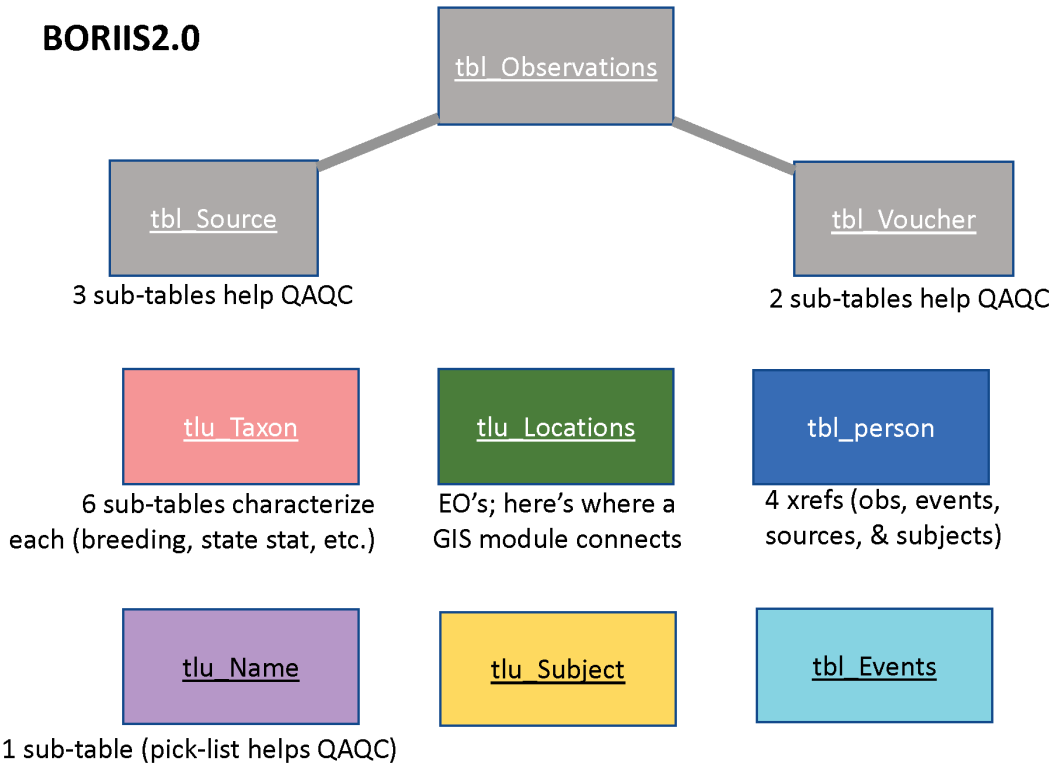
Ideally, vouchers would be in such a form as to be diagnostic. However, this is not always possible. For example, many photographs cannot show every diagnostic feature of an organism. Furthermore, the Survey does not have the resources to consult every voucher in every remote collection firsthand. Having a voucher that is not utterly diagnostic does not by itself disqualify an Observation from BORIIS2. Ultimately the soundness of an identification is dependent on its connection to the Observer, and the Person table and its ancillaries have fields to record a person’s areas of expertise or an assessment of their reliability as an identifier. Furthermore, as mentioned above, BORIIS2 contains provisions to record uncertainty as to the identification of the observed organism, uncertainty expressed by either the observer or by the Survey.

5.0 BORIIS2 ESTABLISHMENT (2 Phases)

After the database is designed, coded, and installed, an Establishment phase is anticipated. Based on initial investigations and the limits of initially available funding, the Establishment phase is envisioned as having two sub-phases. The first sub-phase includes activities undertaken with the funding currently available: QAPP development, conceptual design and testing, scoping, vendor inquiries, contracting, prototype development, core data input, prototype testing and acceptance, initial development of Standard Operating Procedures and Operations Manual, roll-out to stakeholder group with testing and feedback, roadmap and budget for future development, and management/reporting (see 2.7 Timeline for details). Some of this work was done with Survey funding prior to the commencement of NBEP funding. The rest is expected to cover approximately calendar 2024 and will result in the prototype or minimum viable product which includes certain core functionality.

The second Establishment sub-phase includes added features, further Operations Manual and training development, and additional data loading and testing, reporting, and stakeholder engagement, and it is envisioned as covering approximately calendar 2025. Additional funding is likely to be needed for this. The Establishment phase transitions to the Operations phase (see 7.0) when BORIIS2 is ready to run on an ongoing basis, likely sometime late in calendar 2025.

5.1 *Establishment Phase 1: Initial Loading and Testing*: Broadly, BORIIS2 contains two categories of information: **Lookup tables**, which are by in large static, and **Observations** . . . the who, what, when, where, and how (see Figure 4). After limited testing of the empty database, the first information to be loaded will be the Lookup tables.



4 Schematic of ancillary tables supporting basic BORIIS2 functionality

5.1.1 *Lookup Tables*: Lookup tables (preceded by the initials “tlu” in a table name) contain lists of things such as the names of people and places, the accepted nomenclature for taxa, and characteristics of species such as nativity. They help to characterize the Observations that are connected to them. They support dropdown and autocomplete fields which speed manual data entry and, importantly, help reduce data entry errors. Lookup tables will largely be preloaded during BORIIS2 establishment.

There are broadly three types of lookup tables: 1) those that contain encyclopedic information such as place names and voucher repositories, 2) those that contain acceptable values for descriptive variables such as voucher format, name type, and location determinator type, and 3) those used to tag values in tables with characteristics that change over time and need periodic review and updating, such as heritage status, invasiveness, or breeding status.

Type 1—Encyclopedic Information: These tables contain for example lists of named places in Rhode Island or lists of museums where vouchers could be located. They will largely be populated from BORIIS1 as they were relatively complete and clear of errors when it was developed, and these lists have not changed much. Before installation, Survey staff will review the data tables for consistency with BORIIS2 structure and standards, making changes where necessary. In BORIIS2, fields allow data migrated from BORIIS1 to be marked to that effect. Upon initial loading and implementation, there will be a continuing need for additional work to add any new, needed values or in case errors are discovered, but the tables’ content will become increasingly static over time.

Type 2—Descriptive Variables: These tables contain, for example, variables such as nativity or subject. They have largely been populated already during the BORIIS2 design phase prior to the present. Some minor alterations to the available values may be required as development proceeds. They will need to be associated with Observations as appropriate where those associations are not brought over from a prior source. The values will be listed and defined in the Operations Manual

Type 3—Living Variables: These tables contain information such as Heritage status (e.g. endangered, threatened, special concern) or invasive status. They have largely been populated already during the BORIIS2 design phase; however, the relationships between them and the values in the taxonomic and nomenclatural tables they help characterize will, by in large, need to be established once they are populated. For example, the Heritage Program has established the Heritage status of 562 listed taxa and the Rhode Island Invasive Species Council has established the invasive status of 89 species of plants. For other categories, for instance breeding status, a review process will have to be established involving Survey staff and appropriate subject matter experts. Updating living variables in BORIIS2 whenever the determining body changes them will be an operating task (and spelled out in 7.0 below).

5.1.2 *Observations*: The lookup tables are loaded first. As installation of data proceeds, Heritage data will be loaded into BORIIS2, and testing can become more comprehensive and realistic.

The Observation is the unit of data management for BORIIS2, and observations are composed of unique combinations of WHO, WHAT, WHEN, WHERE, and HOW DO WE KNOW (see Figure 2). Observations take the form of relationships among entries in data tables (preceded by the initials "tbl" in a table name)—at least one table each for Person, Taxonomic ID, Date, and Location. Ancillary tables are needed to provide critical functionality, specifically to handle common names and scientific name synonyms (tlu_Name), multi-day time periods (tbl_Events), and taxonomic identification or groupings above the species level (tlu_Subject).

The first block of observations to be loaded will be the Rhode Island Natural Heritage Program Rare Species Data-table. This is currently a single Excel sheet containing approximately 4,500 observations of Rhode Island rare species with each observation on one line, each having 42 columns. This sheet was exported from BORIIS1 in 2013 and numerous QAQC activities have taken place on it since, including confirming details with the original paper records in the Survey archives. The fields are normalized to the fields in the BORIIS2 design. It represents the cleanest, most reliable data currently available for use in developing and testing BORIIS2. These Observations will be the first imported, and they will be marked as to their origin using the accession fields provided.

5.1.3 *Testing, debugging, hosting, and acceptance*: Testing the BORIIS2 prototype product is the responsibility of the Principal Investigator with input from the Data Clerk and QA Manager. Testing will be carried out by Survey staff running specific database operations similar to common or tricky real-world uses, for example viewing and updating tables, importing spreadsheets of Observations, searching and filtering data in typical ways and exporting a report of the result.

The contractor is not selected as of this date, and so there is not yet a finalized list of milestones or deliverables against which to test the delivered BORIIS2 prototype. The desired milestones and deliverables are laid out in the Request for Proposals Instructions to Contractors:

- Building and documenting, at least to the demonstration level, the backend, frontend, and user interface (UI), with metadata, of a relational database as described, with the possibility of pushing off development of refined features to a later phase as necessary;
- backend and frontend having organization and functionality suitably similar to MS Access schema and other documents provided during informational interviews;
- installation and testing of system (all relevant components) on site at the Survey;
- loaded with substantial amounts of test data, specifically the Heritage data table and similar;
- metadata written to a FGDC endorsed standard;
- staff training and written documentation and training materials;
- road map for essential functionality not able to be captured in this phase, possibly spatial module, remote access, etc.

Based on prior experience and discussions with potential contractors, testing is anticipated to be iterative over a period of months as the contractor successively presents:

- the overall technical approach and system architecture;
- database schema;
- developed backend;
- frontend design approach;
- developed frontend;
- hosting environment and deployed pipelines;
- security measures such as SSL certificates and firewalls;
- installed test data;
- documentation (incl. metadata written to a FGDC endorsed standard) and training materials.

A list of test operations cannot be fully developed until the specifications of the contract are finalized. A list of tests will be developed, with input from the BUG, during the months of development and delivery. Tests are likely to include:

- credential creation, revision, and deletion;
- landing page connection to all sub-pages;
- export and sort tables to look for nonconforming entries;
- export Locations and project on a globe to look for gross mistakes;
- noun (e.g. taxon, source, location, voucher, event, person) dossier views;
- security/privacy challenges;
- individual input and output to all tables;
- bulk data input and output to the Observation table;
- documentation (incl. metadata) and training review;
- QAPP compliance.

Testing will be performed by Survey staff and the Executive Director, in his role as Principal Investigator, is responsible for ensuring that the contractor(s) meet the requirements of the contract. The present status of the product and testing results are to be part of the Principal Investigator's monthly report to the Science and Data Committee and quarterly progress reports to the Narragansett Bay Estuary Program. The Principal Investigator has the authority to issue a stop work order, as does the NBEP, the preceding notwithstanding.

The BUG, which meets roughly quarterly, on an ad hoc basis, will be asked for input into development of tests and to review the product against the specified goals.

Following each round of testing, a punch-list describing bugs, oversights, or unanticipated behaviors discovered during testing will be provided to the contractor for resolution, and this process will be iterated until the deliverables are met.

Upon acceptance of the final product (as described in the contract), the contractor will provide a written/digital document describing the final product with a narrative, instructions for carrying

out major functions, a list of products/vendors used, and metadata. The contractor will also provide a written road map for next steps in BORIIS2 development based on project requirements, communications, and progress to that point.

The Principal Investigator is responsible for evaluating the testing and accepting the final products/deliverables. Prior to acceptance, he will report on the testing and recommend acceptance or another course of action to the Science and Data Committee and to the Narragansett Bay Estuary Program Project Officer who can accept that recommendation or recommend a different course.

By the end of 2024, ongoing data management tasks (specifically updates to and requests for Heritage data) are expected to begin taking place using BORIIS2, and the last version of the old Heritage data table will be archived.

5.2 *Establishment Phase 2*: The currently available funds are not sufficient to cover these activities, which is why it is considered a separate phase. The second year of Establishment includes buildout of additional features and installation of other large bodies of existing data. Two other large bodies of existing data that will be drawn on are: a) other BORIIS1 Observations, and b) other data in the Survey's possession but not yet in a database. (For more information on how data are qualified for inclusion in BORIIS2, see 6.0).

In the second year of Establishment, testing and stakeholder feedback are continuous. There is additional engineering and adaptive management in response to testing and feedback. The Establishment phase is concluded in 2025 (see 2.7) by final acceptance of whatever products are contracted, public roll-out, and transition to the Operations phase, guided by Standard Operating Procedures (see below). The road map for further BORIIS2 development will be updated. If additional phases are necessary or desirable to build out certain additional capabilities, they will be identified in that road map and funding can be sought and plans made.

This QAPP expires December 31, 2025, but it may be modified or extended as allowed by EPA before that time. Because ongoing BORIIS2 operations may be different than anticipated at the present time, this would be a suitable time to extend, update, or replace the QAPP, depending on funding.

6.0 DATA QUALIFICATION

The mission of the Survey is to collect, maintain, organize, and distribute as much information on the biodiversity of Rhode Island and its environs as possible to the widest range of users possible. For this reason, BORIIS2 is designed to ingest a wide range of Observations including contemporary and historical, direct and indirect ones.

Examples:

- Records of breeding bird species from the RI Breeding Bird Atlas;
- Photographs of herptiles submitted to RIDEM via its Herp Observer app;
- Lists of species observed during the annual RI BioBlitz;
- Peer reviewed paper containing a list of species found during a pollinator survey;

- Rare plant surveys conducted by plant conservation volunteers coordinated by the Native Plant Trust;
- Inventories of plants recorded on land trust parcels by consultants as part of planning or monitoring habitat restoration projects;
- Lifetime collection of photographic slides of plants found by an amateur botanist;
- Thesis or dissertation describing species located in the course of research;
- Reports by the public of unusual natural historical sightings such as skinks, manatees, or bald eagles;
- A list by genus or species of beetle by-catch in agricultural pest monitoring traps;
- A butterfly collection donated to a local museum;
- Lists of mushrooms, moss, or lichens identified during forays by amateur societies.

Regardless of BORIIS2's built-in flexibility, all Observations going into BORIIS2 from whatever source, during Establishment or during ongoing Operation, must pass through a data qualification process that implements a Data Qualification Model suitable for providing reasonable screening for, for example, veracity, suitability, completeness, and security/privacy issues and conforming to stakeholder and funder expectations/requirements.

Setting the data qualification criteria and procedures is the responsibility of the Survey staff in consultation with Science and Data Committee and stakeholders primarily through the BUG but also through ad hoc groups of subject matter experts that may already exist or may be convened by the Survey as needed. The Data Clerk is responsible for carrying out Data Qualification, using established criteria and procedures, under the supervision of the Principal Investigator and with review at least annually by the QA manager and BUG.

The Data Clerk reviews each batch of data prior to importation into BORIIS2. Observations of potential interest for entry into BORIIS2 may come to the attention of the Survey in a range of ways. Not every observation of every species will be, nor should be, entered into BORIIS2. Some data are clearly not valuable or needed; some are from people or processes known to be unreliable; some just don't make any sense given the circumstances; some are not complete or otherwise not compatible with the BORIIS2 structure.

In an initial assessment of whether an Observation will be entered into BORIIS2, the main criteria are:

a) Value and Need: is this Observation of potential future value to BORIIS2 users and is this Observation likely to be lost, forgotten, or distorted if not entered into BORIIS2? Not every Observation of every species is going to be valuable: for example, it is not a good use of BORIIS2's resources to record innumerable red maple or chickadee sightings or the list produced by every bird or plant walk. On the other hand, some Observations of especially unusual species or species found in exceptional circumstances may turn out to be early harbingers of some important ecological phenomenon but are highly likely to be lost over time precisely because they are so exceptional, making them good candidates for inclusion. To assist in making this decision, the Survey, with the BUG, will develop a list of common species and commonly encountered data aggregations that are typically not entered into BORIIS2.

b) Observer Assessment: is the observer known to be reliable and have expertise in the subject? The Person table, with its ancillary tables, is set up to contain information on education, work, other experience, or other information relevant to the likelihood that certain Observations by certain people are reliable. The Survey may choose not to enter data from certain individuals or enter such data with caveats.
c) Coherence: is this Observation internally coherent? Given what we know of the circumstances, is it remotely feasible that that person could have seen that species at that space and time?
d) Completeness and Compatibility: At a bare minimum, Observations require an Observer, Element Name, Date, and Location as well as at least one Evidentiary Record. Some observations may be incompatible with BORIIS2 because BORIIS2's structure and their content or format, for example a rolling species list with spatial or chronological information that is too broad.

In addition to the above, full criteria that provide reasonable screening for veracity, suitability, completeness, and security/privacy issues and that conform to stakeholder and funder expectations/requirements need to be established as the database design is being implemented. The full scope of review criteria will also consider the following and possibly more:

- completeness and accuracy
- ability to be normalized with BORIIS2 Data Model
- data ownership/rights
- security, privacy, other legal issues
- coverage by and compliance with other QAPP(s)
- compliance with this QAPP

Using data management tools, the Survey leverages the work of innumerable observers afield for a range of reasons, but it does not have the capacity to field verify data. The Survey operates now with, and is setting BORIIS2 up in a way that will provide reasonable procedures for screening data intended for input into BORIIS2 for suitability, accuracy, and other issues. Nonetheless, because data acquired by the Survey are of variable quality, because potential uses are so diverse and have such wide-ranging requirements, and because BORIIS2 is intended to be essentially an index to primary evidentiary records existing elsewhere, it is critically important that users be responsible for judging the suitability of BORIIS2 data for their own purposes. To this end, it is essential that BORIIS be set up to provide users with as much information as feasible on the evidentiary records that substantiate Observations or to make it feasible for users to locate primary, evidentiary records and consult them themselves.

These evidentiary records include Sources—published or unpublished writings—and Vouchers—specimens or photographs. Sources cited in BORIIS may be tangible or digital, and especially with unpublished reports and manuscripts such as fieldbooks and correspondence, are often in the possession of the Survey, and BORIIS2 contains fields to help a user find original documents in the Survey's reference library and archive. With respect to Vouchers, the Survey is by policy not a natural history-collections holding institution (though it does have some small

collections), so vouchers are almost always represented as citations to specimens in other collections, be they in possession of institutions or individuals, and provisions are made in BORIIS2 for suitable fields such as repository name, collection name or number, and specimen catalog number. The Survey does possess an archive of both physical and digital images, and BORIIS2 contains fields to help a user find cited photographs.

In qualifying Observations for inclusion into BORIIS2, balances may be struck based on the Data Clerk's best professional judgment in consultation with Survey and stakeholder resources when appropriate. For example, high value Observations (e.g. first of a very bad invasive in the state, recovery of a rare species) may warrant higher tolerance of observer or location uncertainty, at least so the data can be retained in hopes for future confirmation. To record these balances for future users, BORIIS2 is structured with fields to record identification uncertainty, location uncertainty, observer reliability, overall Observation reliability, as well as other concerns in text notes fields, and change tracking.

Furthermore, a field in the Observation table allows individual Observations to be assigned one of three grades: minimum, standard, and Heritage. The Survey, in communication with the BUG, will set grading criteria as the database design is developed and the Data Clerk is responsible for grading data supervised by the Executive Director, Science and Data Committee, and QA managers, in consultation with the BUG:

Examples of Potential BORIIS2 Data Grades:
Minimum grade: data have value due to the species, observer, or date and are likely to be substantially true, but nonetheless have some inherent uncertainty. A typical example would be Observations based on historical records or historical vouchers in museum collections where there is only a general location. Minimum grade Observations are considered usable for informational, educational, and general planning or for historical studies.

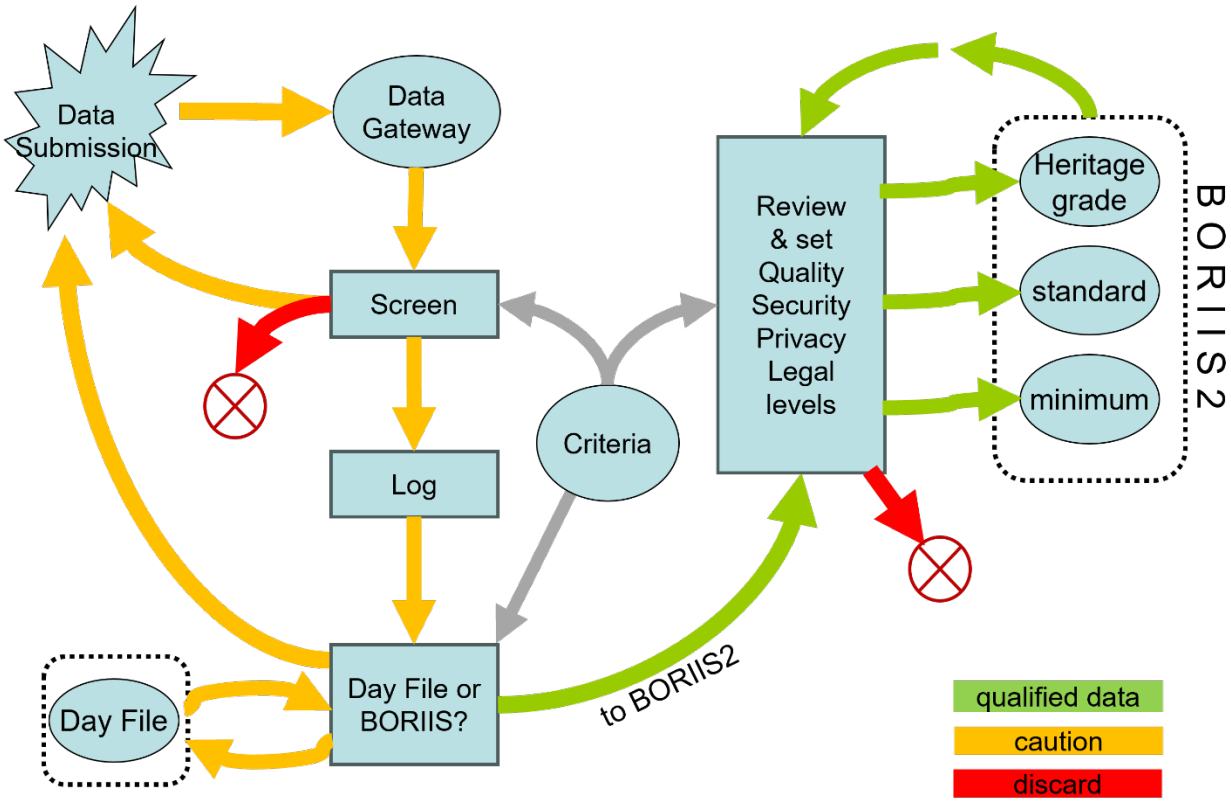
Heritage grade data meet criteria set by the RI Heritage Program (presently this resides at RIDEM) and are suitable for research, planning, and as a screening resource for permitting.

All other Observations are *standard grade*. Depending on the needs of the user, they could be suitable for any use, but some users would probably need to carry out their own review likely including first-hand investigations in the cited Evidentiary Records.

6.1 *Data Qualification Flow* (see Figure 5): Observations or groups of observations that come to the Survey's attention are put in a Data Gateway, a work queue for the Data Clerk (which may be a physical and/or digital "in box"). The Data Clerk carries out an *initial screen* of these data, either individual Observations or groups of related Observations together, using criteria set by the Survey in consultation with the BUG, primarily focusing on Value/Need, Observer Assessment, Coherence, and Completeness/Compatibility. The Data Clerk may move the data along, seek more information from the source, or discard it. Any one Observation or a whole

batch of related Observations may be rejected as incomplete or otherwise below thresholds for inclusion. Data that do not pass this initial screen are discarded.

Data that are not rejected are then recorded by the Data Clerk in a Data Accession Log. This is a spreadsheet(s) where Data Clerk logs groups of related data that pass the initial screen and are being evaluated for inclusion in BORIIS. This memorializes the Survey's contact with this group of data and is analogous to the accesssion log in a museum. Logged groups of data are assessed more intensively against the full range of current criteria. Thorough evaluation takes place using established criteria. This is carried out by the Data Clerk but could involve extended consultations with other Survey staff, the BUG, subject matter experts, or the source of the data itself.



5 BORIIS2 Data Qualification Flow

Observations arriving at the Survey almost always takes the form of or can easily be made into a spreadsheet with lines for each Observation and column headers that match BORIIS2 fields, and BORIIS2 is designed to easily accommodate inputs and outputs in spreadsheet form. Data not in this format already can be made into it at this point.

At this point, the Data Clerk can put an Observation in the Day File or in BORIIS2. The *Day File* is a physical and/or digital file organized by the date of "accession" (hence the name) and by Accession Log number where submitted observations that are successfully screened but subsequently determined not to meet BORIIS2 minimum data standards are retained. They are not discarded outright because experience has shown that these data can often be interesting for

a variety of reasons such as what they show about their source(s) or because later information or reassessment allows them to be verified and upgraded.

Observations moving into BORIIS2 need to be checked against the existing taxonomic table and coded for a variety of variables. The complete list and criteria for coding a new Observation will have to be established after the database structure is finalized. At a minimum, if it is a new taxon, it will have to be coded with Nativity, Invasiveness, Breeding Status, and Security. It will also certainly include Observer Uncertainty and ID Substantiation to account for ID uncertainty and also privacy and ownership. The Location information will have to be transformed to be compatible with BORIIS2 fields. Finally, the Observation must be assigned a grade ("minimum," "standard," or "Heritage") using whatever criteria are established by that time.

The Heritage data table, which will be loaded into BORIIS2 first, is the cleanest, most controlled data available, and the qualification standards for any other data being considered for loading into BORIIS2 can be described in relation to the Heritage data.

BORIIS1 contains approximately 53,000 Observations representing over 9,000 species that come from systematically organized projects including the Rhode Island Odonata Atlas Project and the *Vascular Flora*, the *Beetles*, and the *Mycota of Rhode Island* book projects. These groups of data are reasonably clean and coherent, are the possession of the Survey, and will be the next batch of data prepared and imported into BORIIS2. Observations from these projects will be exported from BORIIS1, cleaned, and verified by comparison to paper and electronic project records, coded as necessary (see above) and imported with appropriate annotations using fields provided.

Other data in the possession of the Survey as of this date but not in BORIIS1 include observations from public programs such as Rhode Island BioBlitz, ad hoc reports by community scientists, and biodiversity inventories performed under contract for agencies and land trusts. Most of these data are the possession of the Survey, but prior to any additional steps, the legal status of data from each source will be confirmed. The Survey has a policy to clarify its right to use, for its broadly defined purposes, data generated through contracts, grants, or programs memorialized by written instruments. For any particular group of observations, the written instruments and other evidence will be evaluated, and legal counsel consulted where necessary to conclude whether the Survey has the right to manipulate and distribute the data. If the Survey has a right to these data, they will be incorporated into a third round of BORIIS2 inputs. The legal status of an observation is recorded using a lookup table that also provides citations to the relevant documents, which appear in the Source table.

7.0 BORIIS2 OPERATIONS

Once Establishment activities are finished, some time in calendar 2025, BORIIS2 will be transitioned to Operational status during which regular procedures are followed. Details of the

regular operations will have to be finalized during the Establishment phase but the following arrangements are anticipated:

7.1 *Hardware, storage, backup*: Prior consultations suggest a MySQL platform. The backend/frontend platform decisions are not yet finalized, however, and the choice of structure will likely be guided by, in addition to the needs/principals outlined here, the expertise of the selected contractor with other factors including initial vs operating cost, user training requirements, likelihood of future updates, and ready availability of qualified software engineers.

BORIIS1 was built in MS Access and runs on a Windows 10 desktop computer. Storage is local with backups following the 3,2,1 best practice—three backups on two different media and at least one copy off site. BORIIS2 is designed using MS Access. It is a specification that BORIIS2 be designed to track changes to key tables by date and by signed-in user as well as to have full version control. BORIIS2 will be served from the cloud, though in which cloud (Azure, AWS, Google, etc.) is not decided yet, and accessed via the internet from suitable clients with provision for suitable security and access control.

BORIIS2 will also follow the 3,2,1 back-up best practice. There will likely be redundancy in the off-site, cloud storage. Currently, on-site physical backups of software and files are stored locally with, but disconnected from, their respective computers in offices locked when not in use. Deeper backups are kept in a fire resistant safe in the Survey administrative office. A similar arrangement will likely be made with BORIIS2.

The Data Clerk is responsible for maintaining the specified backup routine/schedule. The Principal Investigator/Executive Director is responsible for checking that this routine/schedule is being followed. The QA Manager can doublecheck that this is being followed as part of his/her periodic audit.

7.2 *Data Clerk*: The Data Clerk, or others whom he/she supervises, is responsible for day-to-day operation of the predecessors to BORIIS2 and many specific details of BORIIS2 development and will be responsible for day-to-day operation of BORIIS2, including maintaining paper and electronic records and documenting operational procedures. The Data Clerk reports to the Executive Director who is also the Principal Investigator. The BUG and Survey Board of Directors through its Science and Data Committee, provide additional advice and oversight, and the Principal Investigator chairs the former and reports to the latter.

> 7.2.1 *Qualifications and Training*: A model job description for the Data Clerk will be included in the Operations Manual (see below). It is expected the Data Clerk will be hired with basic experience/skills. The incumbent Data Clerk needs to be conversant with taxonomy and nomenclatural practices, geographical information systems, and the exigencies of fieldwork as well as basic collections management/library science practices. Familiarity with other biodiversity database facilities such as GBIF, Arctos, or EoL is a plus. It is more important that he/she have a rigorously systematic and detail-oriented character than have extensive experience/skills in any one database application.

A new Data Clerk would be trained on BORIIS2 by the Executive Director or vice versa. Between this kind of continuity, the Operations Manual, and BORIIS2's simple and intuitive design, no specialized training would be required. BORIIS2 is being developed in such a way that operators can get by with common levels of computer familiarity but do not need specialized computer or database skills.

7.3 *Quality Assurance Manager*: The QA Manager is the Chair of the Survey's Science and Data Committee or his/her designee. During regular Operations, the QA Manager conducts audits at least annually of all Data Management activity to ensure compliance with the QAPP and other established procedures and policies. The QA Manager will set the schedule and criteria for these audits once the full program is set. The QA Manager will submit a written report to the Science and Data Committee with a copy to the Principal Investigator/Executive Director. The Science and Data Committee may accept the report, return it to the Principal Investigator/Executive Director with a memo requesting corrective actions, or reject it outright. The Committee may accept a report even if minor shortcomings are identified, but material shortcomings require correction or the report must be rejected. If the report is accepted, it is forwarded to the BUG and interested parties, for example funders such as NBEP. If it is rejected outright, it is forwarded to the BUG and interested parties with a memo describing corrective actions that have been required and a timeline for definitive action.

7.4 *Operations Manual and Standard Operating Procedures*:
In Operation, BORIIS2 will be supported by an Operations Manual that will lay out responsibilities and standard operating procedures (SOPs) for essential and major activities such as data qualification and input and request fulfillment, QAQC procedures at various stages, security reviews, BUG communication, an annotated index of fields, and a glossary of accepted terms. Writing/compiling the Operations Manual is the responsibility of the Data Clerk under the supervision of the Principal Investigator with assistance from the QA Manager or others as appropriate. Notes for the Operations Manual are being made throughout the development process, and the Operations Manual will be finalized at the conclusion of the Establishment phase.

- Instructions: A description, with screenshots where appropriate, of how to do typical BORIIS2 operations such as data entry, data filtering and export, account creation and removal, backup, etc., specifics to be determined during development.
- QAQC Routine: A description, with timeline/schedule, with screenshots where appropriate, of routines performed on BORIIS2 in order to a) affirm that the content and structure BORIIS2 remains as expected, b) detect inconsistencies within data already in BORIIS2, c) conduct a security audit ascertaining whether security measures are functioning as designed. This list will have to be fully developed once the database structure is finalized. The QA manager has final authority over this list and schedule. This will include a description of the roles and responsibilities of the QA Manager under this QAPP.
- List of Living Variables needing periodic verification/updates and schedule.

- Data Request Assessment Model: written model by which to evaluate data requests, based on requested data security and privacy, in order to ascertain what level of specificity to provide for a request (see Criteria below).

- Compendium of Established Criteria for Operational Decision-making: Criteria specified in models described in this document will be spelled out in the Operations Manual, each criterion including a statement about who wrote it and who can change it. These will need to be finalized in the future. The Survey (PI, Board Committees, and QA manager) are responsible for developing these criteria in close consultation with stakeholders, primarily those in the BUG. (Note: In Rhode Island criteria for Heritage or other conservation status of species is established by RIDEM under statutory authority. BORIIS2 simply associates such statuses with the appropriate Taxon_ID records.).

    - logon with read-only access to BORIIS2
    - logon with editor access
    - initial screen for new Observations
    - Day File versus BORIIS2
    - When/how to redact details in responding to a data request
    - For a taxon . . .
        - Security requirement
        - Nativity
        - Invasiveness
        - Breeding status
    - For an Observation . . .
        - acceptable location information
        - Privacy requirement
        - BORIIS2 quality grade

- Conditions of Use including data request disclaimer and statement of data limitations: agreed to by people when getting direct access to BORIIS2.
- Data License: must accompany data releases from BORIIS2; there may be several different versions such as for partner organizations, private individuals, or consultants.
- Security and Privacy Statement: describes data identified by the specified process as having security and privacy concerns.
- Taxonomic Authorities List.
- Observation Data Standards including written criteria and a Data Qualification Model
    - incl. list of species and sources not typically entered into BORIIS
- Annotated Index of Database Fields
- Job description for and outline of training for the Data Clerk including his/her role in the main database functions, Standard Operating Procedures, and roles and responsibilities of under this QAPP.

- A description of the roles and responsibilities of the Principal Investigator/Executive Director under this QAPP.
- Glossary including accepted terms
- Contact information for the contractor and other project service providers/vendors

7.5 SECURITY AND PRIVACY:

There are Security and Privacy concerns with certain data planned for BORIIS2. The Survey has ultimate responsibility for identifying and protecting data with security and privacy concerns. It is a requirement in the BORIIS2 specification that there be a log-on requirement. Also, potential BORIIS2 contractors are being provided with a requirement that main tables be set up in such a way that access and changes are logged and auditable.

As part of the BORIIS2 SOP recorded in the Operations Manual, the Survey will develop and periodically review lists of data fields having Security and Privacy issues and develop and periodically review procedures for handling access to and export of data from those fields. This Data Request Assessment Model will be reviewed and approved by the members of the Board of Directors Science and Data Committee with input from stakeholders in the BORIIS2 Users Group (BUG) through a process to be specified at the time Operations commence.

Species Location Information: Certain species are known or could be subject to poaching. The BUG and the Survey work together, with the help of subject matter experts, to create a list of species of security concern and provision is made in the Taxon table to record this status. There is a current Survey policy on data releases with security concerns and this will be adapted for use with BORIIS2 by the Survey in consultation with the BUG once the exact structure of the database and functionality of filters and reports is known.

Location Details and Event Details: Certain fields in the Location table may be sensitive because of the species found on them, privacy, legal and other landowner issues, or inherent hazards, or for other reasons. Information on either could potentially be used to find security species (see above). Therefore, a minimum set of descriptive data for Locations and Events will be developed by the Survey in consultation with the BUG once the exact structure of the database and functionality of filters and reports is known.

Personal Details: Information in the Person table could be sensitive due to privacy concerns. The default for fields in the Person table will be that they are private and not for distribution. However, mandatory fields and fields containing only publicly available information will be indicated as public.

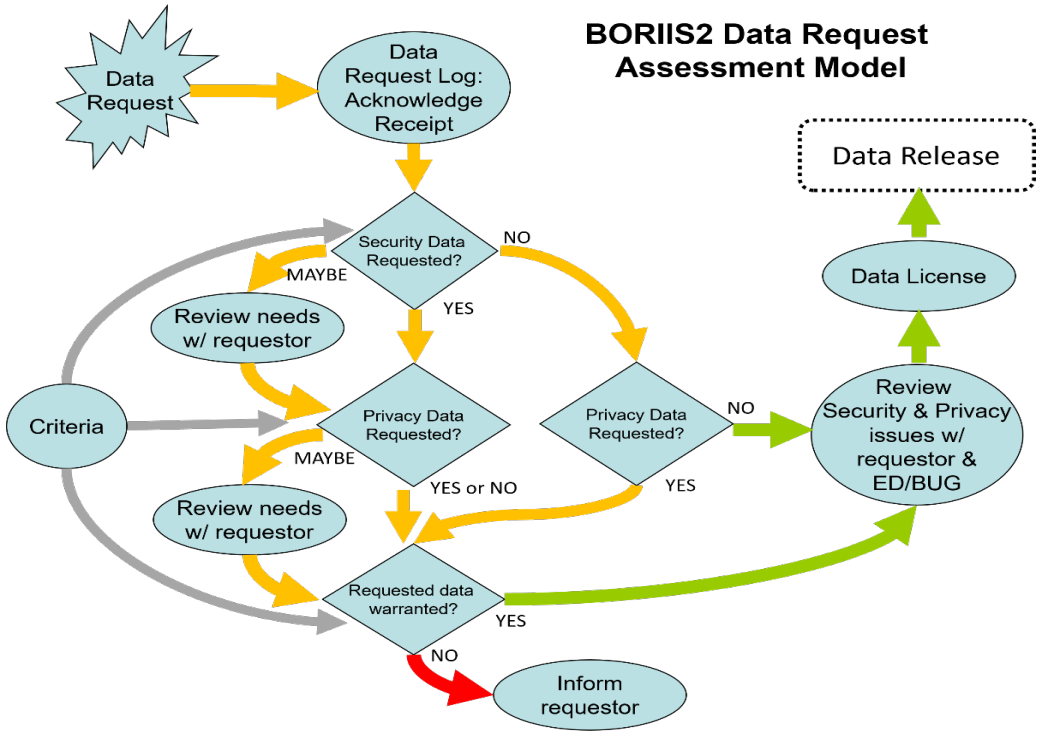
8.0 DATA ACCESS

As described above (see 2.0-.3), the primary direct users of BORIIS2, at least initially, are internal to the Natural History Survey. The current expectation, based on discussions in the BORIIS2 User Group (BUG), is that at least initially external stakeholders will continue to access Heritage (rare species) data from BORIIS2 via static products prepared by Survey staff. After BORIIS2 is operating and the new capabilities are better understood, different arrangements are likely to be made through a consultation process among stakeholders, but it is much too early to anticipate what these arrangements might be.

For now, the process which is likely to continue is: twice per year the Survey generates an Excel table of data on observations of Heritage species and transmits it to The Nature Conservancy, URI, and RIDEM. TNC and URI have internal uses only. RIDEM uses the table to respond to requests for data by state government parties and by commercial consultants. The Survey uses this table to respond to requests from conservation organizations and researchers.

For assessing requests for data, the process followed by RIDEM and the Survey is already established through discussions among Heritage data partners. The parties have agreed to respond to data requests with the minimum specificity necessary for the purpose of the request. This will be the initial standard for BORIIS2 data whether Heritage data or other data.

Data requests are fielded by the Survey or RIDEM directly or are referred to them. At the Survey they are brought to the attention of the Data Clerk. The Data Clerk acknowledges receipt of the request with the requestor and logs it into the Data Request Log noting at least the date received, date needed, name of requestor, nature of the project, and nature of the data requested.



6 BORIIS2 Data Request Assessment Model

The Data Clerk next checks the data requested against established criteria to see if it involves any security issues (in BORIIS2 this would be data with particular values, to be established, in the security fields). Regardless of the security status, an assessment is made as to any privacy issues with the data requested (with reference to appropriate database fields). Additional consultation with the requestor may again be required. If both reviews are negative, the request is reviewed by the Survey Executive Director, and, if approved, the Data Clerk prepares a suitable data disclaimer (see sample in Appendix 1), data license (see sample in Appendix 2), and data package and forwards them to the requestor. If either the security or privacy review is positive, the Data Clerk consults with the Executive Director and/or other parties as necessary to come up with a data package that provides the least specific data possible consistent with the security and/or privacy issues. This may require that the request is denied entirely.

This assessment follows the model in Figure 6. Any different assessment criteria or procedures would need to be developed by the Survey in consultation with stakeholders via the BUG.

9.0 OTHER CONSIDERATIONS

9.1 *Cyber protection*: BORIIS2 will follow the 3,2,1 backup strategy described elsewhere in this document. At least one backup will be "cold," that is not connected to the internet. Suitable certificates, encryption, firewalls, and login requirements are an anticipated deliverable of the contractor (not yet chosen). In this stage, there will be only two access tiers, one for trusted Survey staff and one for the engineers/contractor. In future scenarios, limited or read-only access tiers may be implemented and decisions about boundaries applied to those tiers will be made in the future as those scenarios develop. As BORIIS2 will be served from the cloud, physical access is not as much of an issue as it might otherwise be. Nonetheless, the Data Clerk's and Principal Investigator's workstations are in locked private rooms within a public building that is locked after office hours. There is fire alarm protection but no sprinklers or access alarms. The area is patrolled by Campus Police. The workstations are completely shut down overnight to limit exposure to cyberattacks and secured with Windows PINs using two-factor authentication. They are updated and run Windows Defender. They connect to the internet via the University of Rhode Island's network and are thus behind the URI firewall. As part of BORIIS2 installation, encryption of web traffic will need to be implemented to the extent it is not already.

9.2 *Potential for evidence of illegal activities*: Information that comes to the Survey in the course of its data operations is not typically suitable or sufficient for, nor is the Survey qualified to judge compliance of others with laws and regulations. Nonetheless, by policy the Survey is committed to complying with all applicable laws and regulations. Incoming data will be reviewed for potential to evidence illegal activity. If, in the course of its activities, the Survey becomes aware of illegal activities, the Executive Director will be informed. He/she gathers information and consults with the Board of Directors and may contact appropriate authorities.

The Survey will not consider requests by data sources to obscure, redact, or withhold data due to fears of exposing illegal activities by others. Deliberately anonymous Observations do not meet minimum threshold for inclusion in BORIIS2 (all Observations must have an Observer) and Observers requesting anonymity due to privacy concerns will be encouraged to allow the use of their name. Observations remaining anonymous will be filed outside the BORIIS system (for instance in the Day File) annotated appropriately.

9.3 *Chain-of-Custody*: While it may contain data or perform analyses of value to legal procedures such as permitting, enforcement, or civil actions, BORIIS2 is not expected to provide or document authenticity of evidence for such legal procedures. It is designed with reasonable allowance for recording provenance of and internal changes to data, but it is not suitable for chain-of-custody maintenance and recording.

9.4 *Data Ownership and Public Records*: The ownership status of incoming data is ascertained during the Data Qualification Flow after the Day File vs BORIIS2 decision is made and it is recorded in database fields arranged for this use. As the Survey is a private 501c3, it is not, in and of itself, subject to Open Records requirements in Rhode Island. Conditions of certain funding sources and project arrangements may make certain Survey records subject to Open or Public Records requirements, and the Survey is committed to complying with applicable laws and regulations.

9.5 *Whistle-blowers*: The Survey has a written whistle-blower policy incorporated into its Employee Handbook and this would apply to staff and volunteers working on or in BORIIS2.

10.0 DOCUMENTS/REPOSITORIES INTEGRAL TO BORIIS OPERATIONS

Changes to the operating features/documents may be expected to happen as the actual product is developed and deployed but something similar to the following arrangements are anticipated:

Data Gateway: A physical and/or digital holding pen where incoming data are sequestered prior to initial screening.

Data Accession Log: A spreadsheet(s) where Data Clerk logs groups of related data that pass the initial screen and are being evaluated and then coded for inclusion in BORIIS2, including notes as to their ultimate disposition.

Day File: A physical and/or digital file where data submissions that are successfully screened but subsequently determined not to meet BORIIS2 minimum data standards are retained. It is organized by Accession Log #. Experience is that these data can often by interesting for a variety of reasons such as what they show about their source(s) or because they are later verified, so they are not discarded.

Data Access Log: Two components:

a) Credentials Log: a spreadsheet(s) of people with access to BORIIS2, with appropriate associated information

b) Data Request Log: spreadsheet(s) where the Data Clerk logs requests, with associated information, including references to other documents, for data and tracks their progress through the Request Assessment (see Model) to data delivery. The receipt of the request is acknowledged at this point.

Change Log: A spreadsheet(s) where the Data Clerk logs the date, names, and references to other documents, for any work performed on the BORIIS structure, as opposed to its content.

Operations Manual and Standard Operating Procedures (see above)

Data release disclaimer language (see Appendix 1)
Data license (see Appendix 2)

11.0 CONCLUSION

Ultimately, users must be informed of and remain cognizant of the fact that BORIIS2 is an index and a screening tool. Its primary purpose is to support planning, outreach, and research. In BORIIS2, the highest grade of data is the Heritage data standard, and data meeting this standard can be identified and filtered into or out of any search. Nonetheless, there are weaknesses even in Heritage grade data that are inherent to the methods by which BORIIS2 data are collected and handled. Highly consequential decisions should not be made without consulting original documents or specimens and/or making new, firsthand field observations.

Appendix 1

RINHS Data Request Disclaimer Boilerplate [SAMPLE]

Data from the Rhode Island Natural Heritage Program are provided to you under a revocable license. You may use these data solely for the purposes stated in your inquiry and subsequent communication with the Rhode Island Natural History Survey. As these data may be time sensitive, you may use these data for one year, after which you agree to destroy or delete them or to request an update if your need for them continues. These data are for the internal use of the requesting party: you agree not to make these data or anything derived from them which substantially reproduces them available to other people, companies, or agencies except in direct pursuit of your original purpose in requesting them. Any breach of these conditions could result in revocation of your license to use these data.

The data provided are those available to the Rhode Island Natural Heritage Program and considered active or current as of ___DATE___. We cannot provide an assessment as to the significance of these species to any particular project; if you need such an assessment, you should engage a qualified specialist. These data are compiled over many years from numerous sources of varying quality. Reasonable efforts have been made to evaluate the quality and currency of these data. These efforts, however, do not necessarily include field verification, and they remain limited by their methods of acquisition. There may be other information about rare species in your project area that has not been submitted to the Program, and there is no systematic survey of land in Rhode Island so there may be other rare species not yet discovered in your project area. Information provided to you in this email may not be everything we know about rare species populations in your project area because, due to the risk of poaching, we try to provide the minimum information to meet your need. If you need more information, let us know, and we can talk about what more we can provide.

The Rhode Island Natural History Survey is an independent, 501(c)(3) non-profit with a mission to engage those knowledgeable about Rhode Island’s animals, plants, and natural communities with each other and with those who can use that information for research, education, and conservation. The Natural History Survey provides data management and other support for the Rhode Island Natural Heritage Program under the terms of a now expired agreement among the Survey, URI, RIDEM, and The Nature Conservancy. The Natural History Survey is non-advocacy and is neither a regulatory authority nor an agent of the State of Rhode Island. The Survey's ability to provide these data is funded by the generosity of its members and by a grant from the Conservation Stewardship Collaborative Fund at the Rhode Island Foundation.

Appendix 2

Digital Data License [SAMPLE]

RI Natural History Survey
P.O. Box 1858
Kingston RI, 02881
(401)874-5800
info@rinhs.org

License for Use of Natural Heritage Resources Information

Information on rare animals, plants, and natural communities of Rhode Island is provided using a database that is managed by Rhode Island Natural History Survey ("the Survey") under terms of a Memorandum of Understanding that at one time existed among the Survey, the University of Rhode Island, the Rhode Island office of The Nature Conservancy, and the Rhode Island Dept of Environmental Management. Per the terms of this MOU, the Rhode Island Natural History Survey hereby grants a revocable license to:

_____(*Licensee*)

to use the following data:

_____

for the following purpose:

Use of these data is subject to the following conditions:

1. The license is nonexclusive and revocable and the data remain the property of the Survey;
2. The license is nontransferable, and any attempted transfer is void;
3. Solely for the above purposes, licensed data may be manipulated and entered into electronic systems that are controlled by the Licensee and maintained with reasonable security measures;
4. Licensed data may be shared with NPT employees, contractors, and volunteers who: A) sign a Data Security Agreement substantially the same as that shared by NPT and attached to this license; and B) agree to abide by all the terms of this license;
5. The license conveys no rights for Licensee to release or distribute these data, or derivative works containing these data in any way or for any purpose not specified herein;
6. Licensee will identify "Rhode Island Natural History Survey" or "RINHS" as a data source on any product produced using the data and provide the Survey with a list of any reports or printed materials prepared using the licensed data, and a sample copy of such material if requested by the Survey;
7. Licensee understands and acknowledges that release of precise species locations may threaten natural heritage resources. Licensee agrees to take reasonable precautions to ensure the security the data on computers and elsewhere;
8. Licensee agrees to share costs incurred by the Survey in making the data available: Licensee agrees to pay the Survey $_____ within 30 days of being billed;
9. Disclaimer- These data are being provided for planning, observational, and informational purposes only and are delivered with the following disclaimers that the Licensee hereby acknowledges:
    a. For the geographical extent agreed, the data show the natural heritage occurrences reported to the Survey and entered into the database at the time the data were provided. The quantity and quality of data are dependent on research and observation of many individuals and organizations and in most cases this information is not the result of comprehensive or site-specific field

surveys. For these reasons, the Survey cannot provide nor should the data be taken to be a definitive statement on the presence, absence, or condition of biological elements anywhere or at any particular site.

b. Many areas have never been surveyed and not all survey data are reported to the Survey. Absence of information for a given geographic area, or lack of current information for a given area, does not categorically mean the absence of sensitive species or features. Review of these data is not to be considered a substitute for an on-site survey, environmental assessment, or legally required review or field survey.
c. The Survey makes no statement as to the significance of the species reported in the data with regard to the Licensee's purpose in reviewing the data. The Licensee should have qualified people review the data in light of any planned site-specific projects or activities, assess significance, and interact with the appropriate regulatory agencies as required by relevant statute and regulation.
d. These data have been gathered over years from disparate sources of varying or unknown reliability. Though reasonable effort has been made to verify this information, the Survey makes no guarantee with respect to the currency or accuracy of any specific piece of information being provided and accepts no responsibility for decisions made based on the information supplied.
e. The Survey is an independent non-profit, non-regulatory organization and is not empowered to represent or act on behalf of the State of Rhode Island with regard to planning or regulation.

10. Licensee understands and acknowledges that the accuracy of these data is time- limited. By the following date: _____ the Licensee will cease to use these data for any and all purposes and will either:
    a. Upon request of the Survey, certify that all copies of these data have been destroyed or returned to the Survey; or
    b. Complete arrangements with the Survey to receive a comprehensive update to these data and an updated license.
11. Each Party to this License shall be responsible for its own acts and the results thereof, and shall not be responsible for the acts of the other Party and the results thereof. Each Party, therefore, agrees that, with respect to the other Party(s), it will assume all risk and liability to itself, its agents or employees, for any injury to persons or property resulting in any manner from the conduct of its own operations, and the operation of its agents or employees under this Agreement, for any loss, cost, damage, or expense resulting at any time from any and all causes due to any act or acts, negligence, or by the failure to exercise proper precautions, of or by itself or its own agents or its own employees.
12. This License is the entire agreement between the Parties with respect to the subject matter hereof. It shall be construed in accordance with the laws of the State of Rhode Island and may be amended only in writing signed by both parties.

By accepting digital natural heritage resource information, Licensee acknowledges and agrees to abide by all of the above conditions. Licensee shall sign this license and return it to the Survey to indicate receipt and acknowledgment of the terms of this license.

Signed:

_____	_____
Licensee Authorized Representative	For the Survey
_____	__David W. Gregg, Ph.D._____
Printed Name	Printed Name
_____	__Executive Director_____
Title	Title
_____	_____
Date	Date