May 29, 2018

Documents:

Meeting Agenda
Meeting Minutes
Read-Aheads and Presentations

RGSM Population Monitoring During 2017 [report not included]

MRGESCP Progress Update and Requirements Gathering [presentation]

RGSM Population Monitoring During April 2018 [report not included]

ScW/HR Charge

Rio Grande Silvery Minnow Population Monitoring (1993-2017) [presentation]

Middle Rio Grande Endangered Species Collaborative Program

Est. 2000

Science/HR Workgroup
Meeting Agenda

May 29, 2018 1:00 PM – 3:00 PM
Location: U.S. Army Corp – 4101 Jefferson Plaza NE

Conference Call Information:
Phone: (712) 451-0011 Passcode: 141544

1:00-1:10	Welcome, Introductions and Agenda Review ➢ **Decision**: Approve meeting agenda	*Ashley Tanner*
1:10-2:10	Annual presentation of the results of the RGSM population monitoring effort	*ASIR*
2:10-2:20	Review of April 24, 2018 Science/HR meeting • Action items update	*Ashley Tanner*
2:20-2:30	Update on SOWs development • Economics SOW • RGSM Overbanking SOW • HR SOWs • Future SOW?	*Ashley Tanner and Debbie Lee*
2:30-2:55	DBMS data discussion	*Debbie Lee*
2:55-3:00	Additional items, follow-ups, and next meeting date • GSA report is now available	*Ashley Tanner*

Middle Rio Grande Endangered Species Collaborative Program

Est. 2000

Science and Habitat Restoration (ScW/HR) Workgroup
Meeting Minutes

May 29, 2018 1:00 PM – 3:00 PM
Location: U.S. Army Corp – 4101 Jefferson Plaza NE

Action Items

WHO	NEW ACTION ITEMS	BY WHEN
WEST	Send ASIR's 2017 Population Monitoring presentation to the ScW/HR group	ASAP
Ara Winter	Email WEST link to book recommendation *Conversational Design* by Erika Hall. WEST will email to group.	ASAP
WEST	Schedule DBMS small group meeting to work on data protocol	ASAP
WEST	Send DBMS link and DBMS survey link to group	ASAP
Kate Mendoza	Follow up with Mo Hobbs (ABCWUA) and Brian Bader (SWCA) for GIS files for inclusion in the DBMS	ASAP
Ashley Tanner	Send list of SOW ideas to the group	6/1/2018
All	Review provide feedback to WEST on the ScW/HR charge, and also review member roster for completeness	6/13/2018
ONGOING ACTION ITEMS		
All	Send focus questions concerning peer review to WEST.	Ongoing
WEST	Develop a Brown Bag presentation on Peer Review.	In 2018
All	Send any map files in any format to WEST to compile and send to John Peterson, USACE.	ASAP

Next Meeting:

- Brown Bag presentation by Mike Hatch June 19, 2018 from 12 PM to 12:45 PM followed by ScW/HR meeting from 1 PM to 4 PM. Location is to be determined.
    - The ScW/HR meeting will focus on scopes of work (SOWs). On the agenda is a presentation from Stephanie Dreilling of Western Ecosystems Technology, Inc. (WEST) on what should go into a SOW. Following that, there will be time to focus on more SOW ideas to develop.

Presentation of the Results of the Rio Grande Silvery Minnow (RGSM) Population Monitoring Effort

- Rob Dudley, of the American Southwest Ichthyological Researchers (ASIR), presented on "Rio Grande Silvery Minnow Population Monitoring (1993-2017)". The presentation began with background including native distribution and the evolution of the project design. Population trends, population estimation versus population monitoring, occupancy versus population monitoring, and comparisons of those studies were also presented. In summary:

- RGSM were notably lower from 2012-2014 compare to 2004-2011. However, their densities increased substantially from 2015-2017.
- Prolonged high flows during the spring were most predictive of increased RGSM density. Prolonged low flows during the summer were most predictive of decreased occurrence.
- Mesohabitat-specific and sampling-occasion density trends both closely mirrored the long-term RGSM density trends.
- Site occupancy analyses estimate that RGSM were sometimes lost from >85% of occupied sites since 2005. However, RGSM occupancy, extinction, and colonization estimate have improved since 2013.

- The following discussion followed during the question and answer period:

  Q: There seemed to be no data for 2012 and 2014.

  A: It was due to no fish being found during the October occupancy data collection.

  Comment (by participant): A subgroup of the ScW/HR has been looking at the population monitoring data ASIR provided. It was noted that with the two years of dry sites, 1994 and 2012, that 1994 had a bump in RGSM numbers as opposed to 2012. This was because it was not dry by October and with that, the dry side issue had been laid to rest.

  Q: Did ASIR look at prior drying because, for instance, a wet October doesn't mean it was wet very long?

  A: Below a certain threshold you do get more drying. It would be useful to have a model which depicts the maximum extent of drying; but that would require a model that says we lost "x" amount of water in a certain year.

  Q: When there are no fish, has there been a correlation made between numbers of stocked fish and number of RGSM counted in the following year?

  A: Stocked fish, which are marked, are excluded from the data.

  Q: What is the reproductive success of hatchery fish?

  A: No one really knows. The answer can only be had through an extensive DNA study, and no one has really done that. Thus by spring or summer, there is no way of knowing from where the counted RGSM were derived.

  Q: What's the comparison between high flow years of 2016 from 2005?

  A: It'd be great to have inundation models but it seems like we maxed out on both but it does seem we had higher levels in Albuquerque but site wise seemed like it we had flooding at Isleta, but anecdotal. You might expect better response in lower flow.

  Q: Does habitat restoration (HR) contribute to RGSM population increase?

  A: Hard to say. It may, however we cannot see in the data where it's impacting the population numbers. Restoration sites will get more flooding (inundate) from a lower flow, but it is hard to study. Keeping those sites refreshed and functioning seems to be key.

- WEST will send ASIR's 2017 Population Monitoring presentation to the ScW/HR group.

Review of April 24, 2018 ScW/HR meeting

- WEST is still compiling GIS files and request map files in any format.
- ➢ Kate Mendoza will follow up with Mo Hobbs, Albuquerque Bernalillo County Water Utility Authority (ABCWUA), and Brian Bader, SWCA Environmental Consultants (SWCA), for GIS files for inclusion in the database management system (DBMS).
- The ScW/HR workgroup charge is to complete the 2018 work plan. All of the group's tasks are related to the seven considerations. The charge now includes a timeline to complete work. The work group should ensure these are realistic.
- ➢ All should review and provide feedback to WEST on the ScW/HR charge, and also review the member roster for completeness.

Update of SOWs Development

- RGSM overbanking SOW is tabled because SWCA is already doing that work.
- HR SOW team met recently and made some progress; however, the team had two SOWs and came out with only one.
- The ScW/HR group will need to look at developing more SOWs; for example, developing a vegetation base layer of the Middle Rio Grande (MRG) to put on the DBMS that can be used by others. U.S. Army Corps of Engineers (USACE) can fund planning and studies but not implementation. Having more than two SOWs is needed to keep Program funding and it is required from this ScW/HR group to bring those SOWs forward to the Executive Committee (EC) to make the funding request of USACE and others.
- The Economics SOW team meeting went fairly well. The Economic scope has changed, as the scope as written was not possible. The team will be looking at HR sites, and whether the cost-per-acre is comparable to other riverine systems as a baseline.
    - Having a big picture of whole program is unattainable because it would be too expensive. We also lack economic evaluation of endangered species and a number of other parameters needed for such a broad analysis. If not done correctly, a dollar number at the end of this process could leave the Program open to criticism.
    - Looking at HR is a good starting point. May then add a look at monitoring to that, etc. Incremental approach might be more attainable. One participant noted an HR baseline would be a useful perspective as it may help put the regional costs of habitat restoration into perspective.
    - Julie Dickey and Debbie Lee of WEST are working to get a robust handle on Program costs. As there are many ways to come up with estimations of cost, WEST will also look at other programs to see if and how they do program cost estimation.
- ➢ By June 1, 2018, Ashley Tanner (WEST) will send list of SOW ideas to the group for consideration at the next meeting

DBMS Development Discussion

- Lauren Sherson of the U.S. Geological Survey (USGS) was introduced. She serves as a liaison between the Program and the USGS Texas office web developers working on the DBMS.
- DBMS meetings have taken place discussing the current and future functionality of the DBMS. One priority is thinking about how data should be stored. We would like to come out with a data protocol.
    - It requires consistency in formatting and how you all want to use the data. The data stored in the Program DBMS are Excel files and we talked previously about having an actual, queryable database.
    - Currently, the DBMS is a giant document repository. Lack of consistency on input making it difficult to look up documents.

- The question we want to answer is: 5 to 10 years down the road, when we download some data, what does the interface look like?
    - Ara Winter recommends a book, *Conversational Design* by Hall, on understanding why conversation is the best model for creating more human-interface design.
- ➢ Ara Winter will email WEST link to book recommendation *Conversational Design* by Erika Hall. WEST will email to group.
- As to data or metadata, when one is looking for fish information, being able to search by author is usually expected or most used. For documents on vegetation, one might look at ecosystem or even agency.
- What data is the DBMS housing, what data should it house?
    - Any data this Program generates (very broad).
    - Data that is often requested across agencies (i.e. temperature data).
- How much effort do we want to spend on mining historic data?
    - It could be part of work requirement; if historic data is used, it should be gathered and entered into the DBMS.
- As a collaborative program, how might others come to the Program to get data?
    - We want better metadata to find historical documents.
    - As a group we could come up with variables important to us for data.
    - Geospatial data is important to this group.
    - A participant referred to mongoDB (java based) as one of many non-relational document centered databases or content management system (another database: plone) for mixed data types as examples.
    - We need contract language as a minimum requirement for our SOWs.
- ➢ Schedule meeting for small group to include Brian Hobbs (Eric alternate), Justin Reale, Michael Porter, and Ara Winter to work on data protocol.
- ➢ Resend DBMS Survey link to group

Additional Items, Adjourn

- The GeoSystems Analysis, Inc. (GSA) Adaptive Management Framework report is on the DBMS, and will be presented June 21, 2018 at USACE
- The next ScW/HR meeting will be June 19th
- There will be a Program barbecue after EC meeting June 28, 2018 at U.S. Fish & Wildlife Services (USFWS) at 1 PM. All are invited.

Present:

Participant	**Organization**
Rob Dudley	American Southwest Ichthyological Researchers
Eric Gonzales	U.S. Bureau of Reclamation
Brian Hobbs	U.S. Bureau of Reclamation
Debbie Lee	Western Ecosystems Technology, Inc.
Mike Marcus	Assessment Payers Association of the MRGCD
Kate Mendoza (phone)	Albuquerque Bernalillo County Water Utility Authority
Lana Mitchell	Western Ecosystems Technology, Inc.
Jake Mortensen	American Southwest Ichthyological Researchers
Yasmeen Najmi	Middle Rio Grande Conservancy District
Matthew Peterson	City of Albuquerque
Michael Porter	U.S. Army Corps of Engineers
Dana Price	U.S. Army Corps of Engineers
Justin Reale	U.S. Army Corps of Engineers
Nathan Schroeder	Pueblo of Santa Ana
Lauren Sherson	U.S. Geological Survey
Ashley Tanner	Western Ecosystems Technology, Inc.
Ara Winter	Bosque Ecosystem Monitoring Program

Middle Rio Grande Endangered Species Collaborative Program

Progress Update and Requirements Gathering

5/3/2018

Meeting Overview

1. Project Overview and Update
2. Presentation of survey results
3. Q&A - Feedback - Ranking
4. Requirement Gathering for Website, Event Handler, Document Library
5. Demos: Mock-up, Security

Team: Justin Robertson (Lead PI, DBA), Lauren Sherson (NM PI), Toby Welborn (Project Coordinator), Shannon Watermolen (Web Design), Florence Thompson (AGS), Joseph Vrabel (Application Development)

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Project Update

Work Plan, Progress, Demo

Work Plan Recap

Phase I - DBMS Migration and Hosting **(done)**

- Migrated to a USGS public web address
- Secure Sockets Layer (SSL) web server (https://)
- Released as-is to insure continuity of service
- Development environment: includes an internal development database, web application, and source code repository will be set up to prepare for future work.

December 2017

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Work Plan Recap (cont'd)

Phase II - Enhancements and Streamlining of Existing Site **(in progress)**

The look and feel of the present website will be updated, ~~keeping the existing technologies as-is (server-side .NET framework, database, etc.)~~.

- Appearance will be modernized to meet current (2017) web standards and best practices.
- Content organization will be improved based on user input and established program relationships.
- *Document search rebuilt (additional)*

June 2018

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Work Plan Recap (cont'd)

Phase III - System Architecture Scoping **(now)**

- Detailed scoping of the system architecture (DBMS and website)
- Meeting with cooperators to gather requirements and feedback
- Will help with role definitions and role-based application use cases
- "Meeting with individuals in existing roles will help the USGS development team design a system that will better fit their needs"
- Mockups to illustrate functionality, iterative process that will require feedback from users throughout process

September 2018

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Work Plan Recap (cont'd)

Phase IV - DBMS Overhaul **(pending)**

- Redesign will use Entity Framework's Code First approach with domain bounded contexts
- Web API OData enabled RESTful web services will be developed to access data
- Front end will be mobile friendly, ASP.NET MVC web application using Bootstrap
- Redesign will be limited to existing functionality of DBSA solution

Details on Progress (as of 5/1/18)

Stand-up DBSA solution

- Code base received
- Existing applications code put into a versioning control system (bitbucket)
- DBSA solution available at https://webapps.usgs.gov/MRGESCP/
- Key functionality of the site is working (including the map)
- Difficulty in refactoring codebase and implementing additional features

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Details on Progress (cont'd)

Move to https:// and associated security issues

- Moved web hosting to a DMZ server with SSL certificates
  - Encrypted network traffic
- Created the new MVC web application base which is using a more secure ASP.NET Identity security implementation.
  - PBKDF2 with HMAC-SHA256, 128-bit salt, 256-bit subkey, 10,000 iterations password hashing
- Security framework flexible to future security needs
  - Two factor, External Services (google, yahoo, etc)

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Details on Progress (cont’d)

New document search module

- New document search engine was necessary due to code refactoring complications.
- A temporary solution to allow for better access to documents in the existing system, while the new system is being developed.
- Uses Telerik AJAX Controls along with bootstrap.

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Details on Progress (cont'd)

GIS data and map services

- Received large data dump from DBSA (duplicates, not organized well)*
- Data for map services stored SQL server gdb z04 → z02 → AGS
- AGS: https://txgeo.usgs.gov/arcgis/rest/services/MRGESCP
- Imagery services need to be reconnected
- Next steps: Create the imagery map services, organize the data+quarantine the junk, evaluate the good data and see if it can be improved
- Future phases: Will need to gather requirements about cooperators needs with GIS data in future

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Details on Progress (cont’d)

User survey and data compilation

- Worked with staff to formulate a series of simple questions
- Distributed to core staff, then to broad group of users
- 17 responses received
- Feedback was overall helpful and productive
- USGS team analyzed result and compiled information for presentation at this meeting

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Secure | https://webapps.usgs.gov/MRGESCP/

Middle Rio Grande Endangered Species Collaborative Program

Welcome Guest
Please Sign In

groundwater

Sign In

Email Me My Password

- Home
- Documents
- Fish
- Habitat
- Water
- Map
- Graph
- Program
- User Support

MRGESCP

MRGESCP is a partnership involving 16 current signatories organized to protect and improve the status of endangered species along the Middle Rio Grande (MRG) of New Mexico while simultaneously protecting existing and future regional water uses. Two species of particular concern are the Rio Grande silvery minnow and the southwestern willow flycatcher.

Program activities include water acquisition and management, habitat restoration, endangered species monitoring, and silvery minnow propagation. Congress provided approximately $115.8 million to Reclamation from FY2001 to 2009 with an approximate non-federal match of $12.7 million to support Program activities. Reclamation serves the leadership role for the Program. Accomplishments include acquisition of over 158,290 acre-feet of supplemental water from willing lessors from FY2003-2009.

View Signatories

< > today

May 2018

month week day

Sun	Mon	Tue	Wed	Thu	Fri	Sat
29	30	1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26

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Tech Stack (as of 5/1/2018)

- Web Server: IIS 8 using SSL
- Application: MVC .NET Framework 4.7
  - ORM: Entity Framework 6.2
  - OData Web Services
  - Mobile Friendly Bootstrap Front End
  - Telerik Kendo UI MVC Controls
- Data Persistence: Microsoft SQL Server 2012 R2

Next: Survey Results and Feedback Session

<BREAK>

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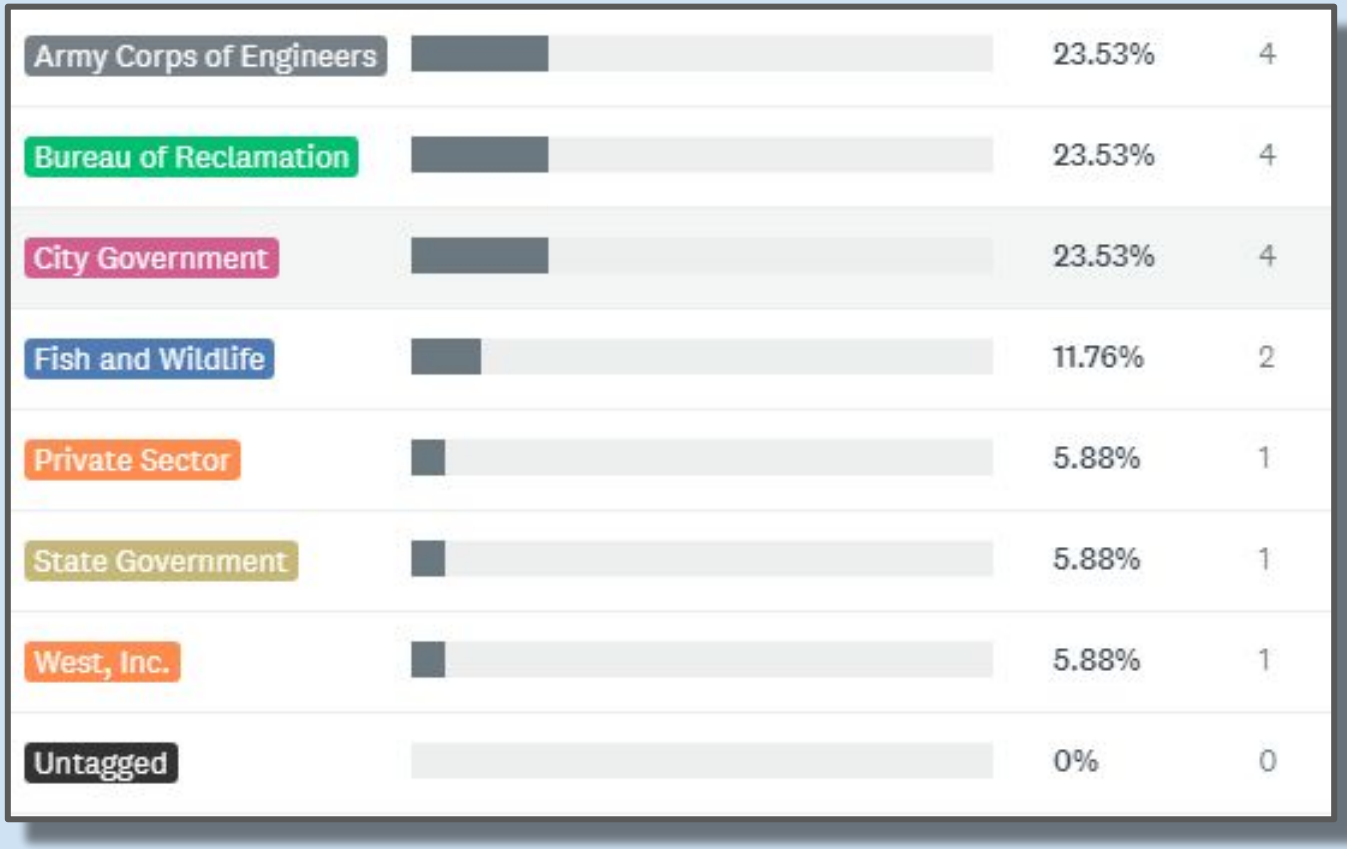
User Survey Results

Summary, More Questions

What agency / organization do you work for?



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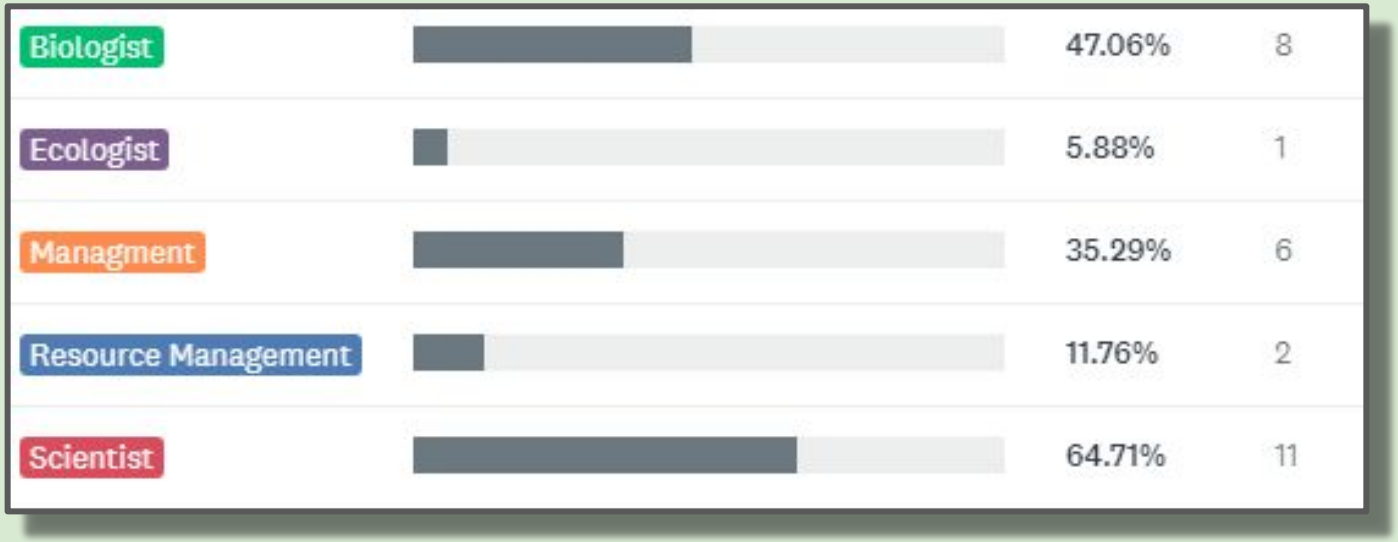
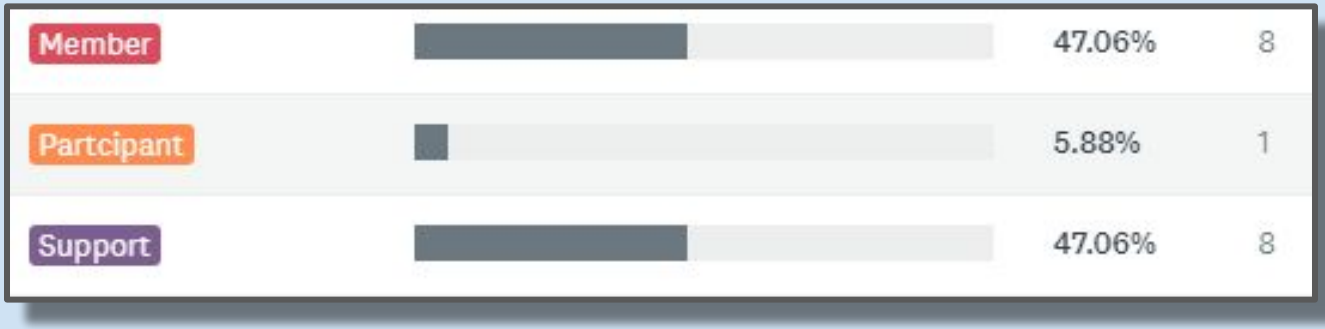
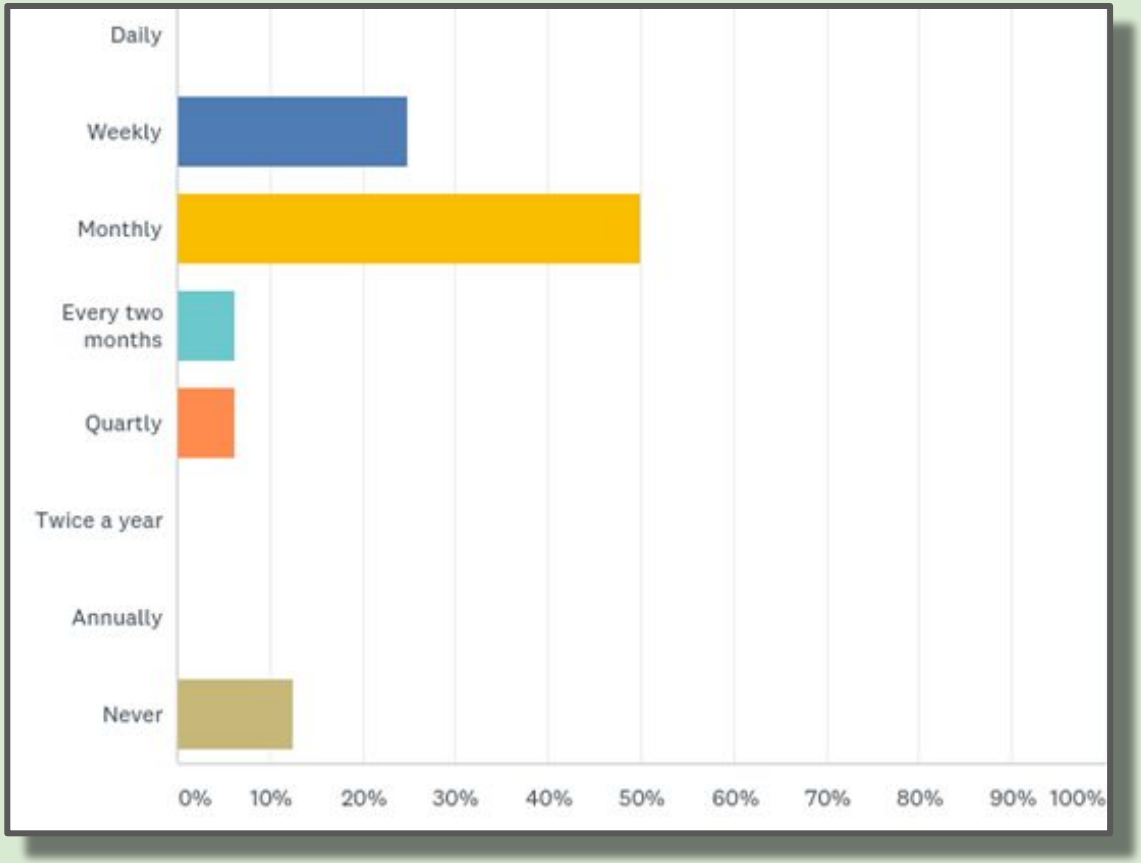
What is your job title?



What role within the MRGESCP?

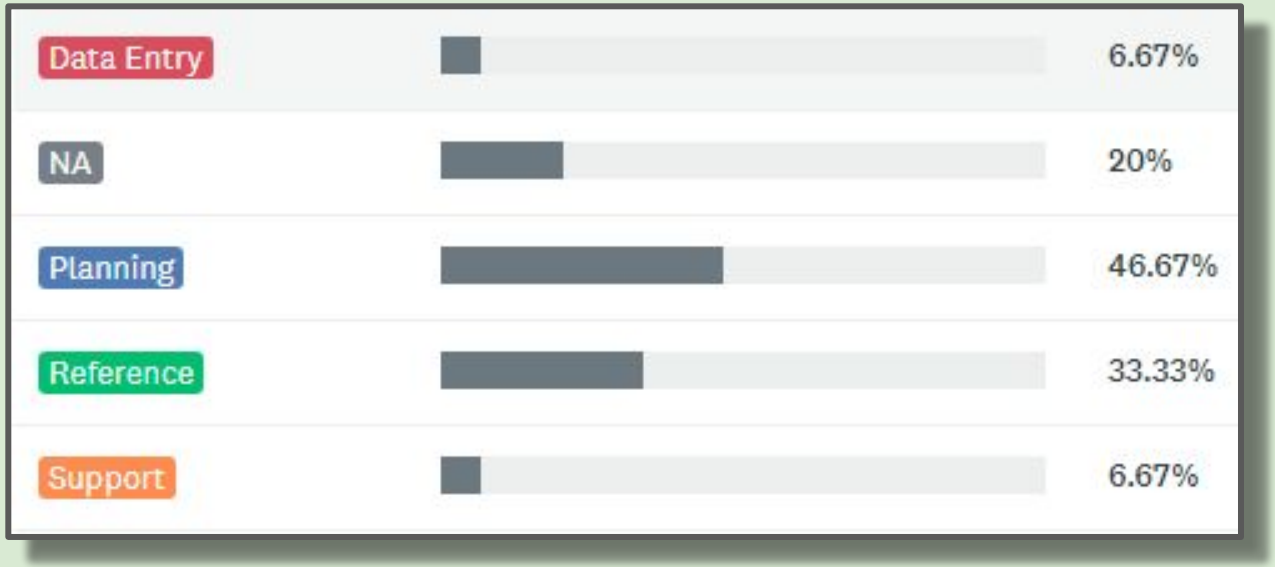


How frequently do you access this application?

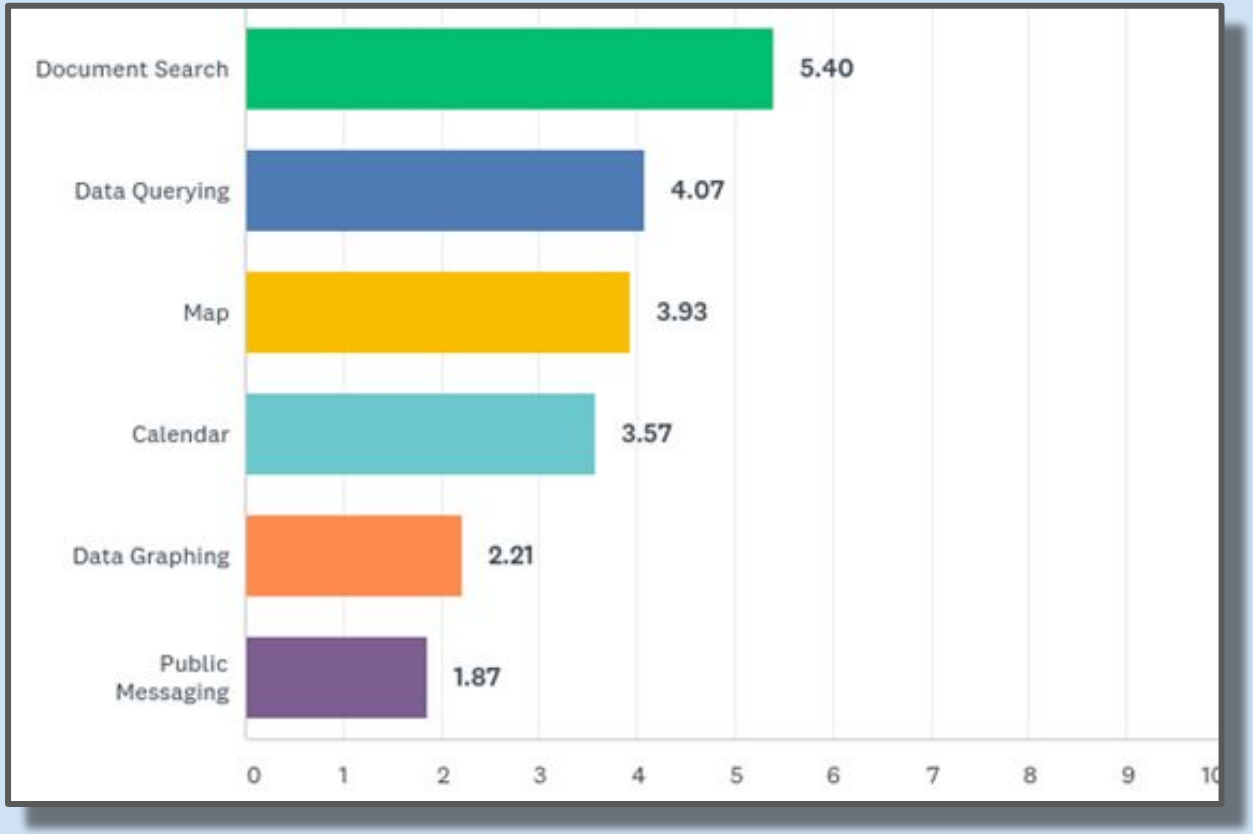


What data do you use from this website?

How do you use information from this site?



Rank the components in terms of importance



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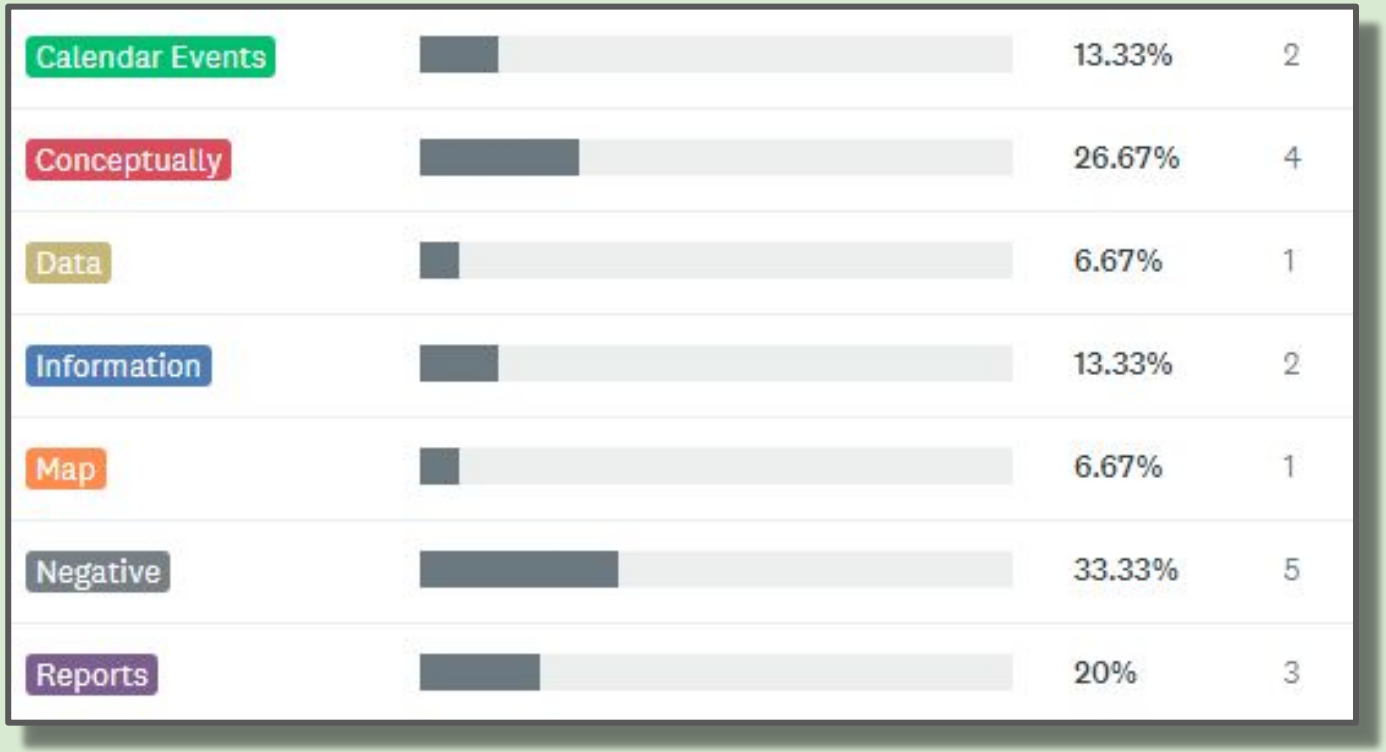
What do you like about the existing website?



What do you not like about the existing website?

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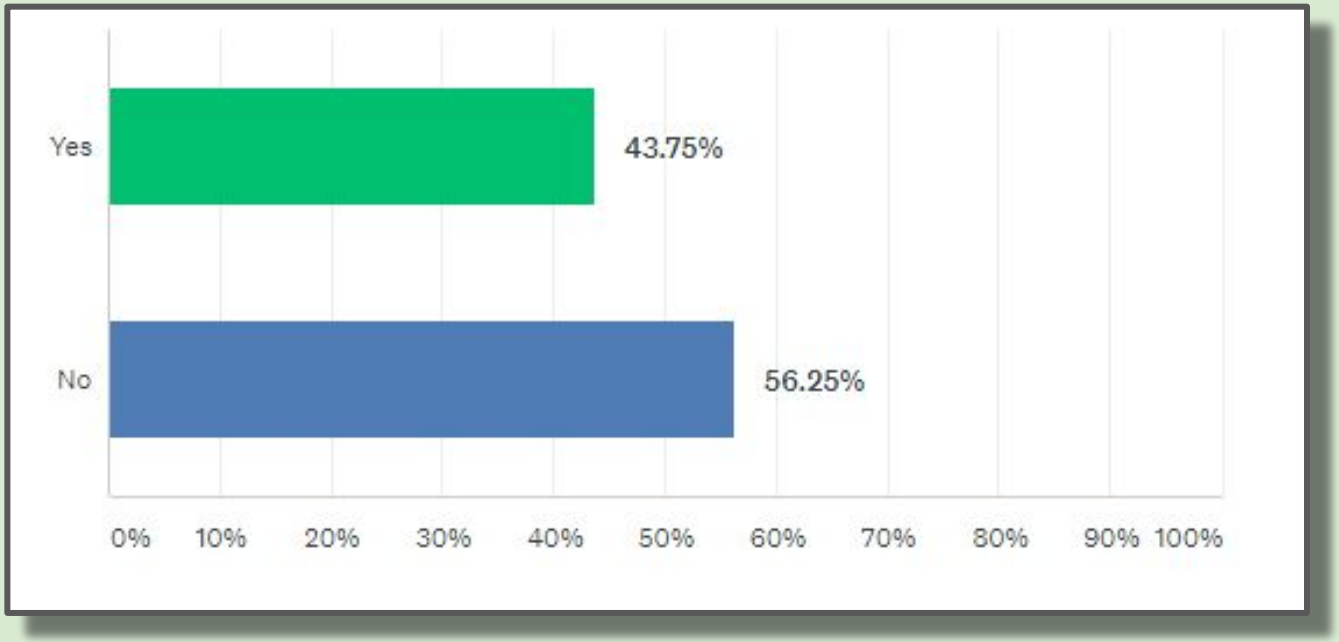
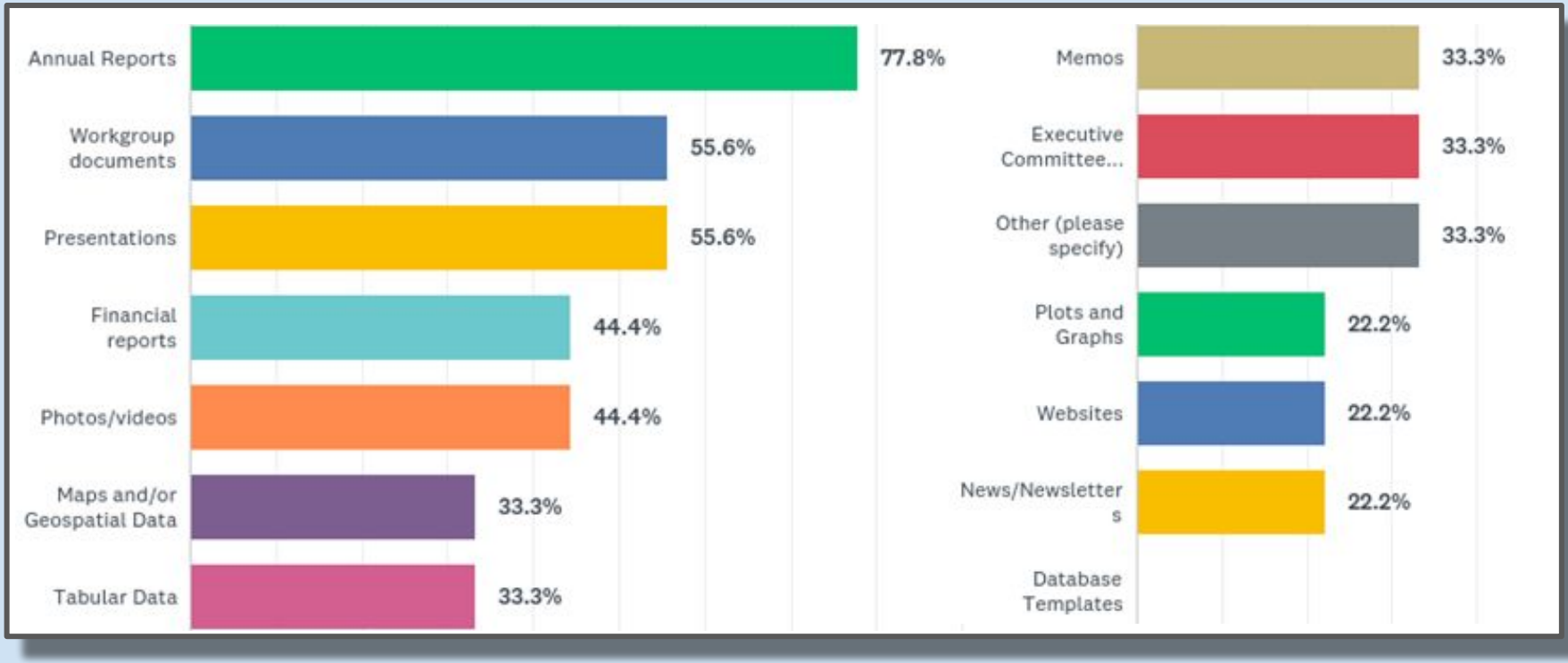
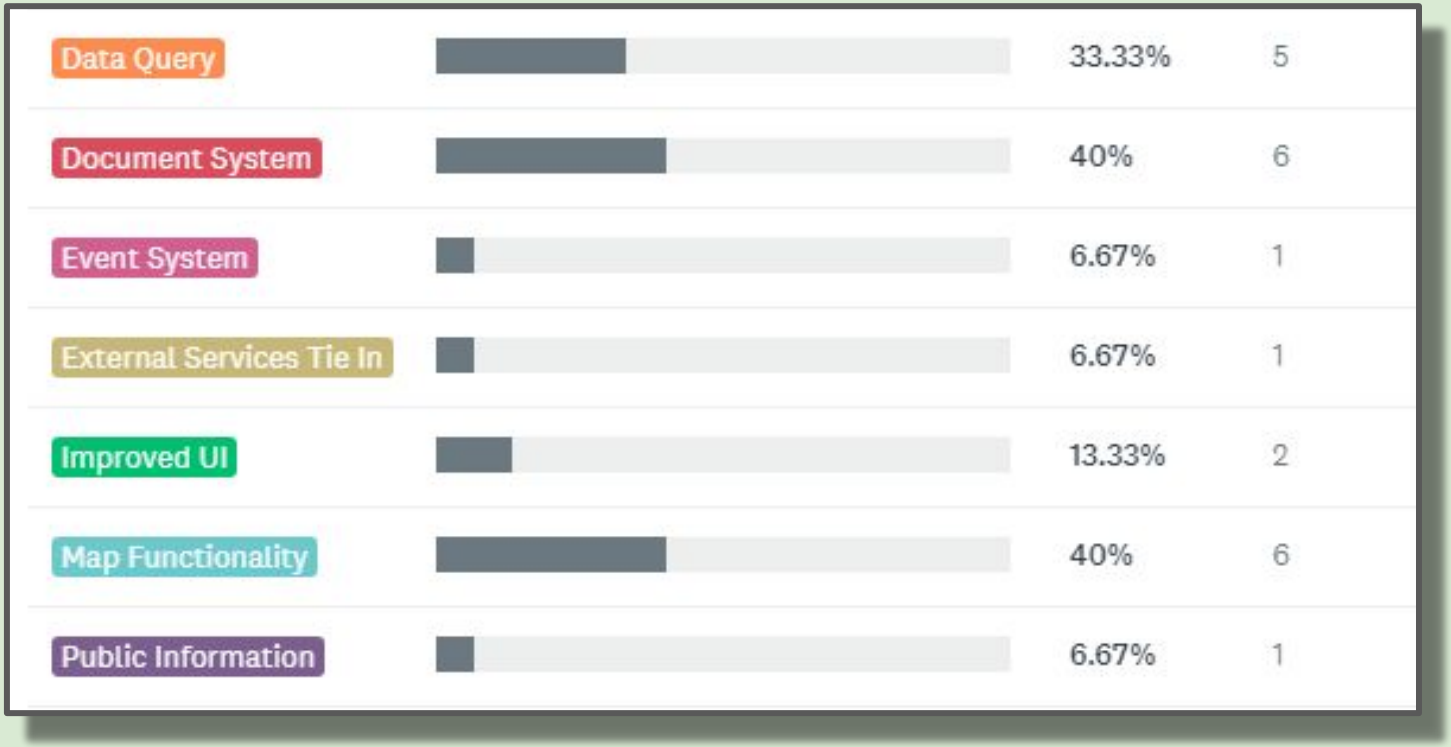
Do you upload documents?



What types of documents do you upload?



What features would you like to see added to the redesign?



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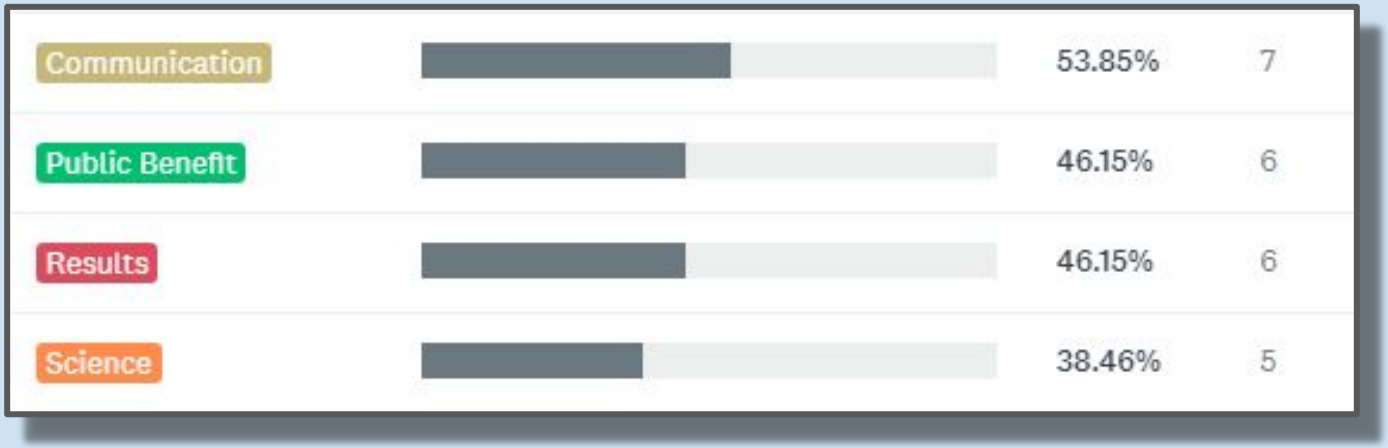
What do you wish the public knew about what the Middle Rio Grande Endangered Species Collaborative Program does?



What is the main message or piece of information that needs to be clearly communicated to the public?

Summary or takeaways (majority wins)

Big Picture

- Major contributors: scientists
- Access: monthly most common
- Important functions: Access to reports and documents, keep up with events
- Reason for coming: Used for planning and for reference

Areas to improve

- UX design, document search and map functions
- Access to documents most important, may need better way to handle data
- Communication - education and importance of work

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Application goals

Internal

1. Document and information storage and discoverability for planning and reference
2. Meeting and decision documentation

External

1. Notification system
2. Provide evidence of accomplishments
3. Mechanism for open and transparent engagement
4. Educate on science

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Additional Feedback (in groups?)

- Can the public message be defined by a mission statement?
- What design and workflow processes fit the internal and external needs? Are they the same?
- Who is being educated and are there descriptions of basic processes for the beginner and/or novice user? How is education be tracked and measured? (BEMP*)
- Are the notifications of events effective? Is there mechanism for tracking?
- Why do you upload data? Workflow for uploading data? What is the value of these data (including geospatial)?

Dot Exercise

Help us understand what functions matter most to you? (Phase I)

- Home
  - Calendar
  - About
  - Contact us
- Documents
  - Searchable library
- Program
  - Activities
  - Financial Data

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Dot Exercise

Help us understand what functions matter most to you? **(Phase II)**

- Map Viewer
- Fish Data
  - Survey
  - Rescue
  - Stockings
  - Egg Drift
  - Food Availability
- Habitat
  - Restoration Sites
  - Treatments

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Requirement Gathering

Specific Functions, Record of Decisions

Summary of decisions (Documents)

- Who should be allowed to see documents uploaded?
  - Public and Internal should be fine?
  - Data Restrictions further than Internal:
    - List Exceptions (Documents with different privileges other than public or internal) for each exception answer the following:
      - Who is uploading the privileged document?
      - What type of document is it?
      - Who uses this document?
      - What purpose does this document have in the system?
- **Decision:**

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Questions for at-large group (Documents)

- What types of metadata do we want to associate with these documents?
  - Authors
  - Title
  - Description
  - Keywords
  - Document Category
    - Reports
    - General Program Documents
    - Others?
  - Subject Category
    - Birds
    - Fish
    - Geomorphology
    - Others?
  - Date of the Document

Questions for at-large group (Events)

- Aside from the typical event metadata (Title, Description, Start, End, Location) what else should we collect?
  - Upload Documents
  - Assign Workgroups?
    - Should assigning a workgroup automatically invite all workgroup members?
  - Invite users and non users by email not in specified work groups?

Demo Mock-ups

Homepage, About page, Document Library

Secure https://dev-webapps.usgs.gov/MRGESCP/home/index.html

MRGESCP

About Documents Events Contact Us

Middle Rio Grande Endangered Species Collaborative Program

The Middle Rio Grande Endangered Species Collaborative Program (Program or MRGESCP) is a diverse partnership bringing 16 federal, state, tribal, local, and university signatories together to address environmental concerns in the Middle Rio Grande (MRG) related to endangered species. The Program's collaborative efforts aim to protect and improve the status of endangered species and their habitats along the Middle Rio Grande (MRG), while also allowing existing and future regional water uses.

In fiscal years 2016 (FY16) and 2017 (FY17), the Program began to shift directions including moving away from MRG Recovery Implementation Plan (RIP) efforts, pursuing an Adaptive Management Program (AMP), developing a new Long-Term Plan (LTP), creating a new database management system (DBMS) and Program website, and supporting the implementation of a new multi-party MRG Biological Opinion (BO). With these changes, and in addition to continued collaboration and support for other MRG BOs and the Program's on-going activities geared toward species recovery, the MRGESCP signatories contracted a third-party Program Management Team (PMT) to support the Program moving forward.

In FY16 and FY17, the following signatories remained partners under the 2008 Memorandum of Agreement (MOA):

- Assessment Payers Association of the Middle Rio Grande
- Pueblo of Isleta

MRGESCP Governance

Adopted in 2008, the Program's by-laws describe the governance structure, the decision-making processes, and the roles and responsibilities of the signatories. The Program's by-laws have been amended over the years, and continued to be updated through FY17 to accommodate Program development. Documents related to governance including by-laws, authorities, and charters, are maintained on the Program's DBMS.

MRGESCP Organization and Structure

The MRGESCP's organizational structure in FY16 consisted of the Executive Committee (EC), the Coordination Committee (CC), the signatory-led PMT, and technical work groups. In FY17, the Program, through Reclamation, contracted Western Ecosystems Technology, Inc. (WEST) as a third-party PMT, but the Program's organizational structure largely remained the same. The following summarizes the roles and functions of the Program's committees, technical groups, and the PMT. More information including meeting documents can be found on the DBMS.

Executive Committee

The Executive Committee (EC) is the Program's governing body and consists of one primary and one alternate representative from each signatory organization. This committee provides policy direction, approves budget recommendations, and holds decision-making authority unless specifically delegated to other committees or work groups. Representatives work to set Program priorities, coordinate policy, and authorize Program activities.

Coordination Committee

Each EC signatory representative appoints a Coordination Committee (CC) member from their organization, and may appoint an alternate. The committee was established to provide Program support by identifying and working to resolve concerns related to Program activities; communicating directives, information, and recommendations between work groups and the EC; and ensuring EC representatives are informed on Program matters.

Program Management Team

In FY17, the MRGESCP contracted WEST, Inc. as a third-party PMT. The WEST PMT provides program and science support to the EC, CC, and work groups. The PMT is staffed by a Program Manager who directs PMT activities and Program support staff, and a Science Coordinator and Deputy Science Coordinator who provide science support to the Program. The PMT is responsible for managing the technical and administrative aspects of Program activities.

The **Middle Rio Grande Endangered Species Collaborative Program** (Program or MRGESCP) is a diverse partnership bringing 16 federal, state, tribal, local, and university signatories together to address environmental concerns in the Middle Rio Grande (MRG) related to endangered species. The Program's collaborative efforts aim to protect and improve the status of endangered species and their habitats along the Middle Rio Grande (MRG), while also allowing existing and future regional water uses.

In fiscal years 2016 (FY16) and 2017 (FY17), the Program began to shift directions including moving away from MRG Recovery Implementation Plan (RIP) efforts, pursuing an Adaptive Management Program (AMP), developing a new Long-Term Plan (LTP), creating a new database management system (DBMS) and Program website, and supporting the implementation of a new multi-party MRG Biological Opinion (BO). With these changes, and in addition to continued collaboration and support for other MRG BOs and the Program's on-going activities geared toward species recovery, the MRGESCP signatories contracted a third-party Program Management Team (PMT) to support the Program moving forward.

In FY16 and FY17, the following signatories remained partners under the 2008 Memorandum of Agreement (MOA):

- Assessment Payers Association of the Middle Rio Grande Conservancy District (APA)
- Albuquerque Bernalillo County Water Utility Authority (ABCWUA)
- Bosque Ecosystem Monitoring Program (BEMP)
- City of Albuquerque (COA)
- Middle Rio Grande Conservancy District (MRGCD)
- New Mexico Attorney General's Office (NMAGO)
- New Mexico Department of Game and Fish (NMDGF)
- New Mexico Interstate Stream Commission (NMISC)
- Pueblo of Isleta
- Pueblo of Sandia
- Pueblo of Santa Ana
- Santo Domingo Pueblo
- U.S. Army Corps of Engineers (USACE)
- U.S. Bureau of Reclamation (Reclamation)
- U.S. Fish and Wildlife Service (USFWS)
- University of New Mexico (UNM)

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Spatial Spawning Periodicity of Rio Grande Silvery Minnow During 2006

PDF Data Reports Fish

Date: 10/01/2006

Authors: Robert K Dudley Steven P Platania

Result and Comparison of 2001-2004, 2006 result

Spatial Spawning Periodicity of Rio Grande Silvery Minnow During 2003

PDF Data Reports Fish

Date: 04/15/2004

Authors: Robert K Dudley Steven P Platania

Result and Comparison of 2001-2003 results. Systematic monitoring of the reproductive output of Rio Grande silvery minnow at several sites in the Middle Rio Grande was first conducted in 1999 and has continued annually (except 2005) since 2001. Previous studies demonstrated May and June as the primary period of silvery minnow reproductive activity. The studies were structured to monitor the spatial and temporal (May-June) reproductive output of Rio Grande silvery minnow in the Middle Rio Grande.

Spatial Spawning Periodicity of Rio Grande Silvery Minnow During 2003

PDF Data Reports Fish

Date: 04/15/2004

Authors: Robert K Dudley Steven P Platania

2003 RGSM Spawning Report. Systematic monitoring of the reproductive output of Rio Grande silvery minnow at several sites in the Middle Rio Grande was first conducted in 1999 and has continued annually (except 2005) since 2001. Previous studies demonstrated May and June as the primary period of silvery minnow reproductive activity. The studies were structured to monitor the spatial and temporal (May-June) reproductive output of Rio Grande silvery minnow in the Middle Rio Grande.

Spatial Spawning Periodicity of Rio Grande Silvery Minnow During 1999

PDF Data Reports Fish

Date: 12/31/2000

Authors: Robert K Dudley Steven P Platania

The historical Middle Rio Grande fish fauna was reflective of a Great Plains river. At least five cyprinid species that can be characterized as Great Plains river fishes formerly occurred throughout the Middle Rio Grande. Spawning by members of this reproductive guild is associated with high-flow events such as spring runoff or summer rainstorms. Upon release, eggs are about 1.6 mm in diameter but quickly swell (ca. 3.0 mm) and remain suspended in the water column during development. The last remaining member of this reproductive guild in the Rio Grande, NM is the federally endangered Rio Grande silvery minnow (Hybognathus amarus). Population monitoring studies have shown an annual decline in the number and catch rate of Rio Grande silvery minnow since 1996. Currently over 90% of the catch of Rio Grande silvery minnow is in the San Acacia Reach of the Middle Rio Grande.

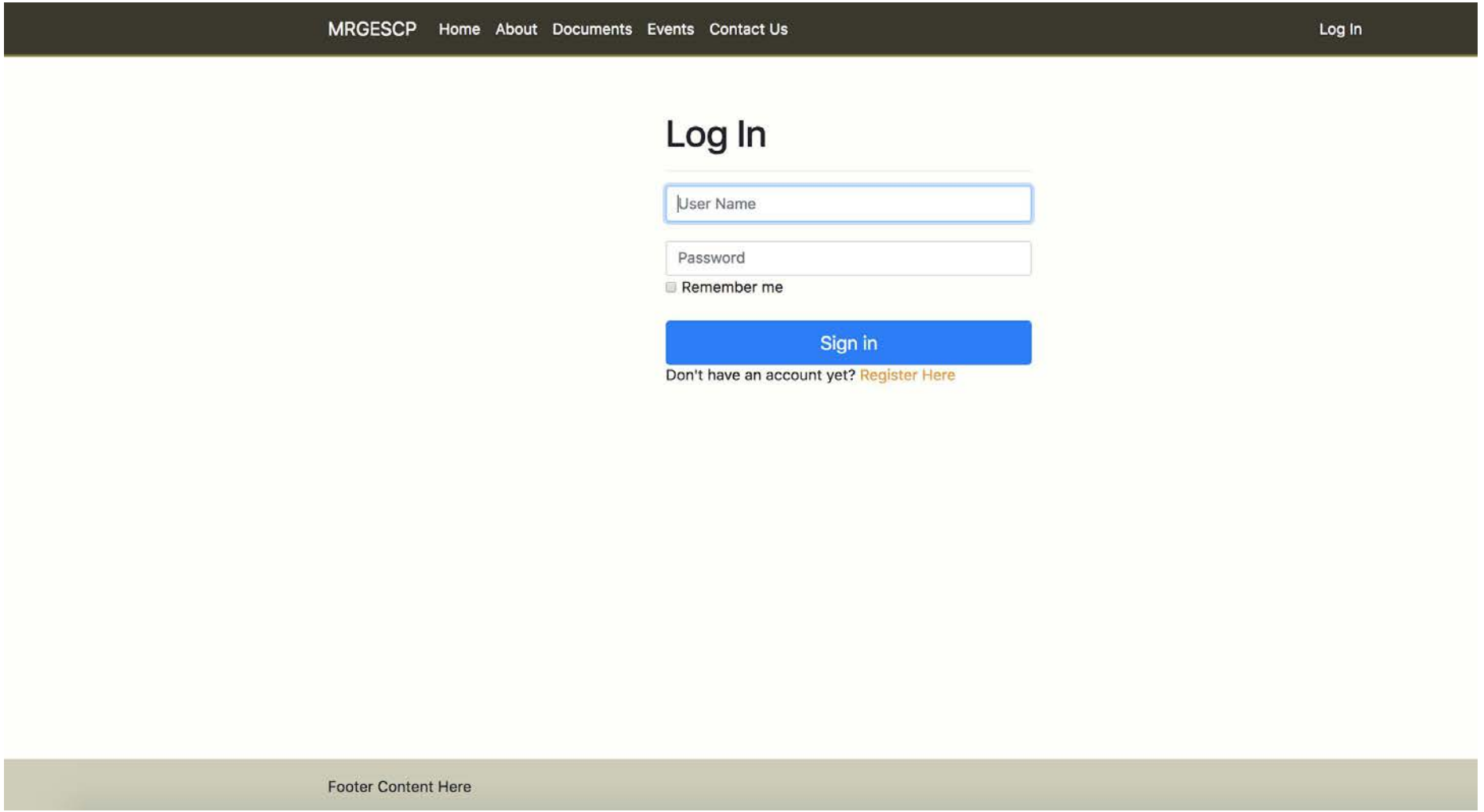
Spatial Spawning Periodicity of Rio Grande Silvery Minnow During 2001

PDF Data Reports Fish

Date: 12/31/2001

Authors: Robert K Dudley Steven P Platania

The historical Middle Rio Grande fish fauna was reflective of a Great Plains river. At least five cyprinid species that can be characterized as Great Plains river fishes formerly occurred throughout the Middle Rio Grande. Spawning by members of this reproductive guild is associated with high-flow events such as spring runoff or summer rainstorms. Upon release, eggs are about 1.6 mm in diameter but quickly swell (ca. 3.0 mm) and remain suspended in the water column during development. The last remaining member of this reproductive guild in the Rio Grande, NM is the federally endangered Rio Grande silvery minnow (Hybognathus amarus). Population monitoring studies have shown an annual decline in the number and catch rate of Rio Grande silvery minnow since 1996. Currently over 90% of the catch of Rio Grande silvery minnow is in the San Acacia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Feedback/Listening Session

- What do you like?
- Suggestions for improvement (for consideration)
- Missing anything?
- Details on how these core components should work?
- Considerations for user roles/permissions
- Other?

USGS
science for a changing world

Contacts

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USGS
science for a changing world

Science/Habitat Restoration Workgroup Charge

Overall purpose:
Complete the 2018 Science/Habitat Restoration Work Plan as approved in the February 2018 Science and Habitat Restoration Workgroup Meeting.

Tasks and Management/Science Implications:
1.) Finish Prioritizing Peer Reviews Recommendations
In recent years, the Collaborative Program has sponsored three independent science panels/peer review panels:

- RGSM Life History (February 2017)
- RGSM Genetics Project Peer Review (February 2016)
- RGSM Population Monitoring (December 2015)

The Collaborative Program has undertaken some prioritization of the recommendations from the panel reports, but has not completed these efforts, or looked at prioritizing the recommendations from all three panels as a whole.

Continuing the prioritization effort will help inform he development of a long-term science work plan, as well as an interim work plan for the next year.

2.) GIS Map of Projects
In 2017, the ScW/HR had begun developing a GIS map of all projects in the MRG. Due to staffing changes at NMISC, that effort had stalled. Completing the map development will inform ongoing and future projects, and help with coordination efforts for on-the-ground activities.

3.) Data Inventory and Consolidation
Since its inception, the Collaborative Program and its signatories have collected a large amount of data, including (but not limited to) endangered species population numbers, hydrology, water quality, and habitat restoration.

There is a need to inventory what data are available where, and if possible, to consolidate datasets. This will inform science and adaptive management activities in the Program, and minimize duplicate monitoring efforts. Data inventory and consolidation will be a targeted effort, concentrating on specific species/datasets of interest in order to better meet the needs of the end data users.

4.) DBMS Development
In 2018, the Collaborative Program will be developing a new DBMS through an Army Corps contract with USGS. This new DBMS needs to be responsive to the needs of the Program, including its scientists and technical experts. The ScW/HR as a group can work with USGS to develop a list of requirements for the database and data management portion of the DBMS. Overall, a DBMS will help the program organize, store, share, and ultimately better utilize data collected and reports written by multiple stakeholders within the MRGESCP.

These services may inspire scientific studies, provide data for scientific research, and allow managers to interact with resources needed to inform decisions.

5.) Habitat Restoration Assessment

The ScW/HR raised the need to go back and evaluate past habitat restoration projects, whether they met projected objectives (why/why not?), and to document any additional benefits from a project. There is an existing SOW from 2007 which the group can update to address this project.

An assessment of past habitat restoration activities will allow the program to learn from past efforts, plan for future activities, and develop studies to fill knowledge gaps.

Note: Project #2, GIS Map of Projects, needs to be completed first.

6.) RGSM Monitoring Plan

As part of the original charge to the Population Monitoring Work Group, the EC had tasked the group with evaluating and refining the MRG Fish Population Monitoring Plan following the completion of the CPUE Workshop. The RGSM Monitoring Plan will detail the methods of fish monitoring for the mutual benefit of all stakeholders who may conduct fish monitoring.

Note: Project #1, Finish Prioritizing Peer Reviews Recommendations, has to be completed first. The current data analysis effort will also inform this effort.

7.) Develop Scopes of Work for EC Consideration

The funding agencies have requested SOWs from the Collaborative Program for inclusion in FY2019 and beyond. Deadlines for the initial list of SOWs (including a short description and cost estimate) are due by the end of April in order to meet Reclamation's deadline. The ScW/HR will use the results of the peer review prioritization effort, old work plans, and individual participant ideas to help identify projects to put forward.

Deliverables:

1.) A final list of all the peer review recommendations with the group's priority ranking, some detail on how rankings were given, and any recommendations for how to move forward with that recommendation.

2.) A complete and current GIS map containing all habitat restoration projects that can be mapped. This layer will ideally be updateable and able to transfer directly onto the DBMS. This layer will be created by the GIS specialists at USACE and the final product housed at WEST until the DBMS is ready to host it.

3.) Data consolidation and inventory will be conducted for targeted objectives. Data consolidation/inventory may be included as one of the first objectives or deliverables for SOWs that requires data from many sources. These final datasets will then move forward onto the DBMS.

4.) The Science/HR workgroup will support the USGS' efforts to develop the DBMS by attending meetings with them, responding to surveys, and providing specific feedback to improve the design/function of the site.

5.) The group will develop a SOW to assess past habitat restoration projects with specific emphasis on the results of monitoring associated with each project.

6.) Use the results of any population monitoring data analyses and reports to update the fish monitoring plan.

7.) Develop SOW descriptions to submit to Reclamation and USACE in mid-April. Write and finalize these SOWs for review by the Science/HR workgroup and EC. Submit final SOWs to funding agencies in September.

Timeline to complete work:

1.) Finish prioritization	July 2018
Develop recommendations to address top priorities	September 2018
2.) Send GIS files to WEST (Ashley Tanner) or John Peterson (USACE)	May 2018
3.) Send GIS files to WEST (Ashley Tanner) or John Peterson (USACE)	May 2018
Identify habitat past restoration projects suitable for analysis	July 2018
4.) Respond to first survey	May 2018
Participate in meetings	Through 2018
5.) Develop first draft of HR SOW	June 31, 2018
6.) Continue to develop Fish Monitoring Plan using best available information.	Through 2018
7.) Develop SOW descriptions and submit to Reclamation	April 15, 2018
Form groups to write SOW	May 2018
Have SOWs ready for EC review	August 2018
Submit final SOW to funding agencies	September 2018

Member roster:

First Name	Last Name	Affiliation
Thomas	Archdeacon	U.S. Fish & Wildlife Service Ecological Services
Jonathan	Aubuchon	U.S. Bureau of Reclamation - Albuquerque Area Office
Jennifer	Bachus	U.S. Bureau of Reclamation
Brian	Bader	SWCA Environmental Consultants
Rick	Billings	Albuquerque Bernalillo County Water Utility Authority
Holly	Casman	City of Albuquerque, ABQ BioPark

Kevin	Cobble	U. S. Fish & Wildlife Service
Ann	Demint	U.S. Bureau of Reclamation- Albuquerque Area Office
Julie	Dickey	Western Ecosytems Technology, Inc.
Kim	Eichorst	Bosque Ecosystem Monitoring Program (BEMP)
Danielle	Galloway	U.S. Army Corps of Engineers
Lynette	Giesen	U.S. Army Corps of Engineers
Eric	Gonzales	U.S. Bureau of Reclamation
Grace	Haggerty	NM Interstate Stream Commission
Debra	Hill	U.S. Fish & Wild Life Service Ecological Services
Brian	Hobbs	U.S. Bureau of Reclamation
Mo	Hobbs	Albuquerque Bernalillo County Water Utility Authority
Ondrea	Hummel	Tetra Tech
Alison	Hutson	NM Interstate Stream Commission
Kathy	Lang	City of Albuquerque
Debbie	Lee	Western Ecosystems Technology, Inc.
CW	Lujan	
Joel	Lusk	U.S. Fish & Wildlife Service Ecological Services
Shannon	Mann	Pueblo of Sandia
Mike	Marcus	Assessment Payers Association of the MRGCD
Maceo	Martinet	U.S. Fish & Wildlife Service
Matt	Martinez	Middle Rio Grande Conservancy District
Yvette	McKenna	U.S. Bureau of Reclamation
Kate	Mendoza	Albuquerque Bernalillo County Water Utility Authority
Yasmeen	Najmi	Middle Rio Grande Conservancy District
Robert	Padilla	U.S. Bureau of Reclamation
Kirk	Patten	NM Department of Game and Fish
Page	Pegram	NM Interstate Stream Commission
Matthew	Peterson	City of Albuquerque
Michael	Porter	U.S. Army Corps of Engineers
Dana	Price	U.S. Army Corps of Engineers
Justin	Reale	U.S. Army Corps of Engineers CESPA-DE
Ken	Richards	U.S. Bureau of Reclamation
Ashlee	Rudolph	U.S. Bureau of Reclamation
Vicky	Ryan	U.S. Fish & Wildlife Service Ecological Services
Stephen	Ryan	U.S. Army Corps of Engineers
Jeff	Sanchez	U.S. Fish & Wildlife Service
Nathan	Schroeder	Pueblo of Santa Ana; Department of Natural Resources
Summer	Schulz	U.S. Army Corps of Engineers
Michael	Scialdone	Pueblo of Sandia
Clint	Smith	U.S. Fish & Wildlife Service
Ashley	Tanner	Western Ecosystems Technology, Inc.
Douglas	Tave	Los Lunas Silvery Minnow Refugium
Malia	Volke	NM Department of Game and Fish

Cody	Walker	Pueblo of Isleta - Natural Resources Department, Water Resources Div.
Kim	Ward	City of Albuquerque
Dave	Wegner	Western Ecosystems Technology, Inc.
Wade	Wilson	U.S Fish & Wildlife Service - Southwestern Native Aquatic Resources and Recovery Center
Leann	Woodruff	U.S. Bureau of Reclamation - Albuquerque Area Office
Brooke	Wyman	Pueblo of Sandia

Rio Grande Silvery Minnow Population Monitoring
(1993–2017)

Robert K. Dudley[1,2], Steven P. Platania[1,2], and Gary C. White[1,3]

[1] American SW Ichthyological Researchers (ASIR); 800 Encino Place NE, Albuquerque, NM, 87102-2606

[2] Museum of SW Biology (Fishes), UNM; MSC03-2020, Albuquerque, NM, 87131-0001

[3] Dept. of Fish, Wildlife, and Conservation Biology, CSU; 10 Wagar, Fort Collins, CO, 80523-1474

Hybognathus amarus (Cyprinidae)

(Rio Grande Silvery Minnow [Girard, 1856])

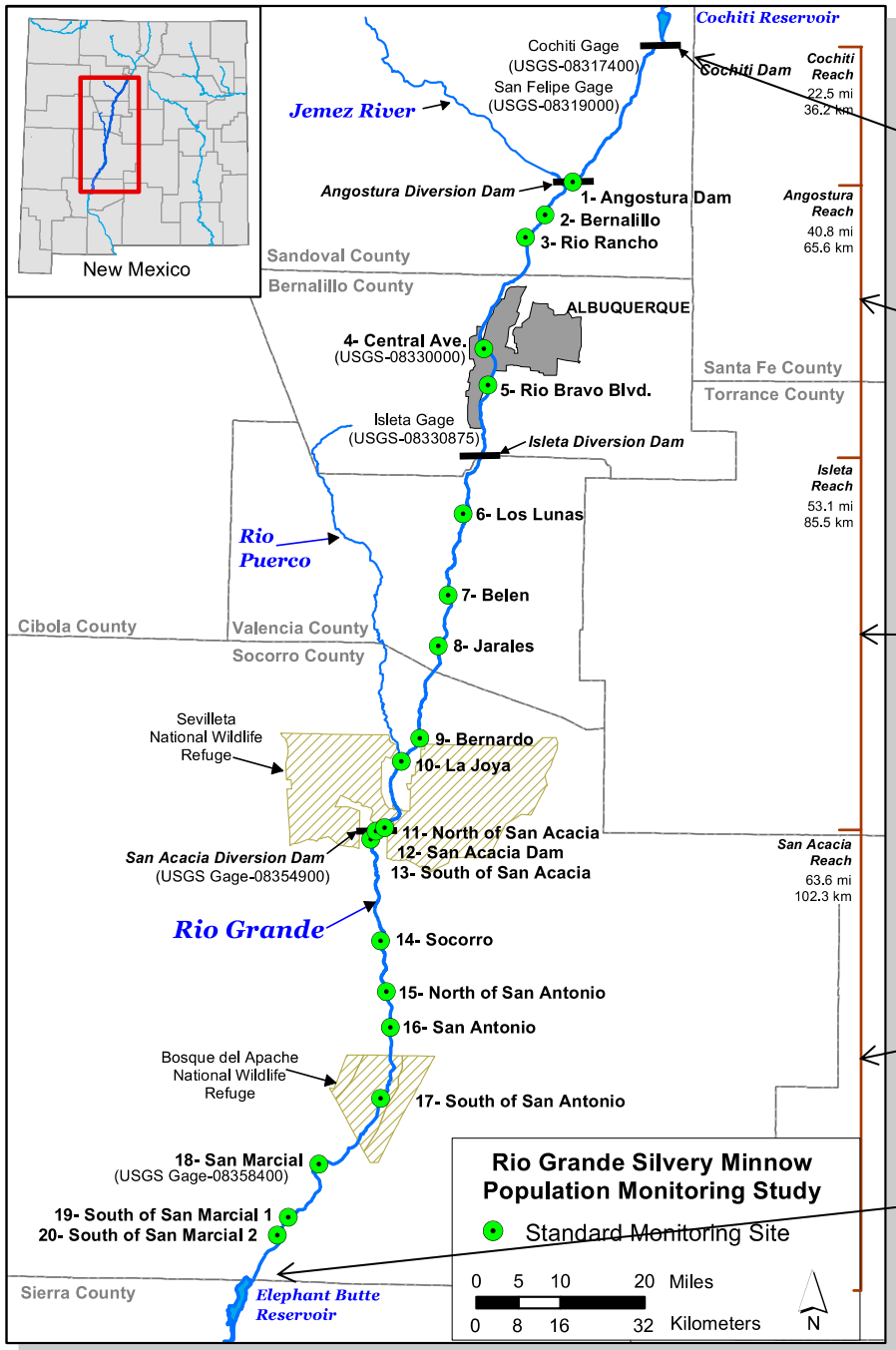
Photo by Tom Kennedy

Native Distribution

(*Hybognathus amarus*)

Current

Historical



Study Area

Cochiti Dam

Angostura Reach

Isleta Reach

San Acacia Reach

Elephant Butte Reservoir

Cochiti Dam

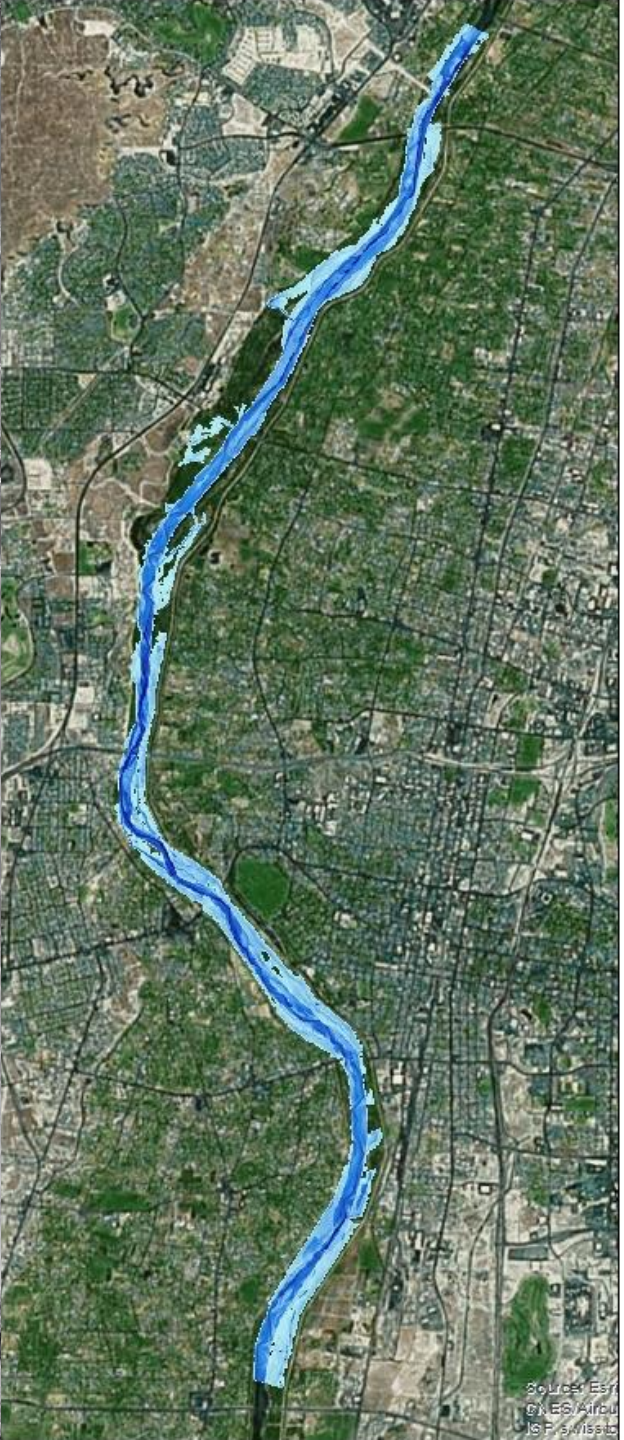
Angostura Diversion Dam

Isleta Diversion Dam

San Acacia Diversion Dam

Elephant Butte Reservoir

Historical and Recent River Channel



Modern Model Inundation

142 m^3/s
(5,000 cfs)

Water Depth (m)

2.5

0

N

W E

S

0 1 2 4

Kilometers

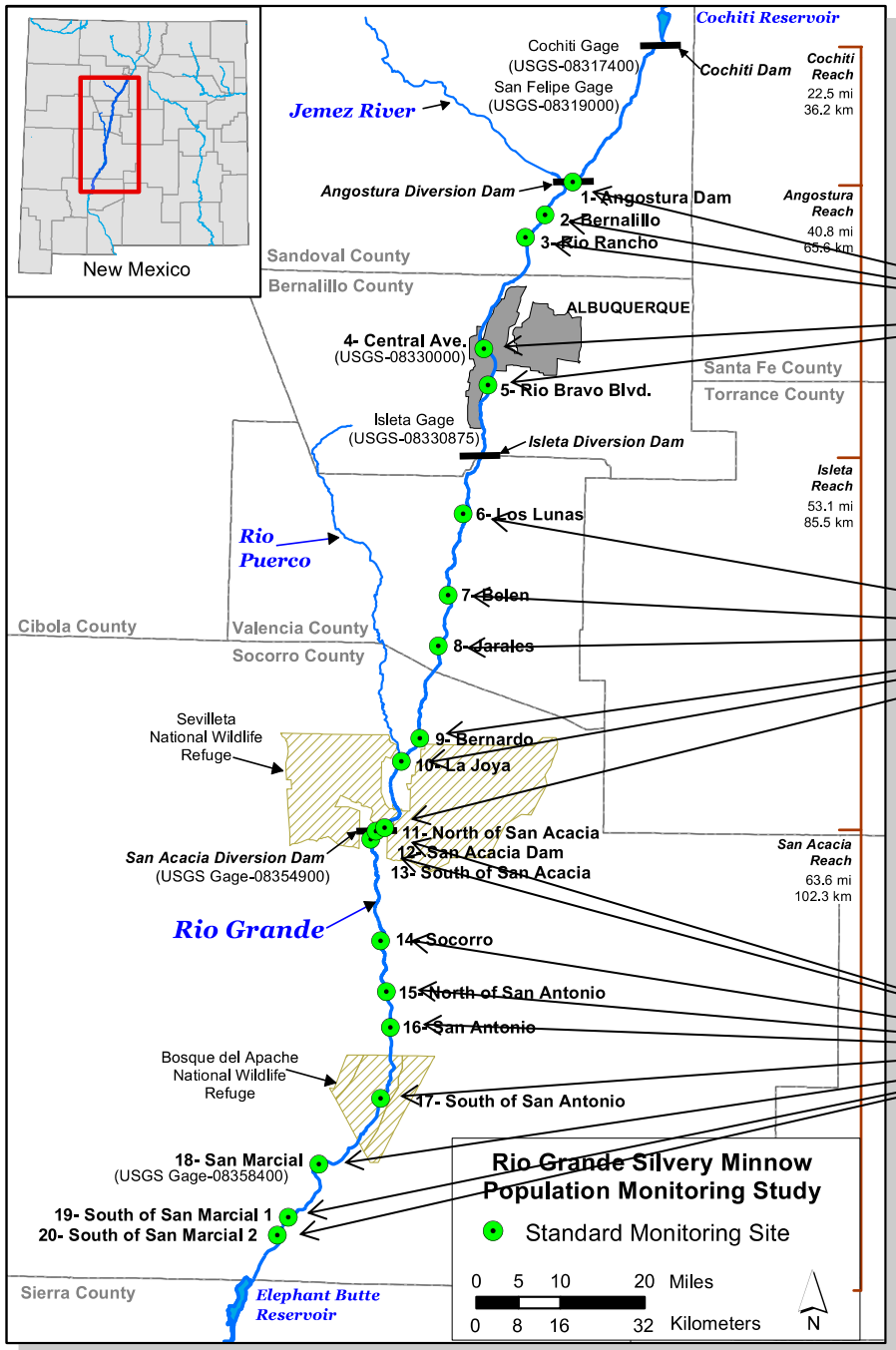
River Inundation

Historical (ca. 1918)
Channel: 19.0%
Floodplain: 81.0%

Recent (ca. 2014)
Channel: 72.9%
Floodplain: 27.1%

Adair, J.B.M. 2016. M.S. thesis, Civil Engineering, UNM, Albuquerque, NM.

Sampling Sites

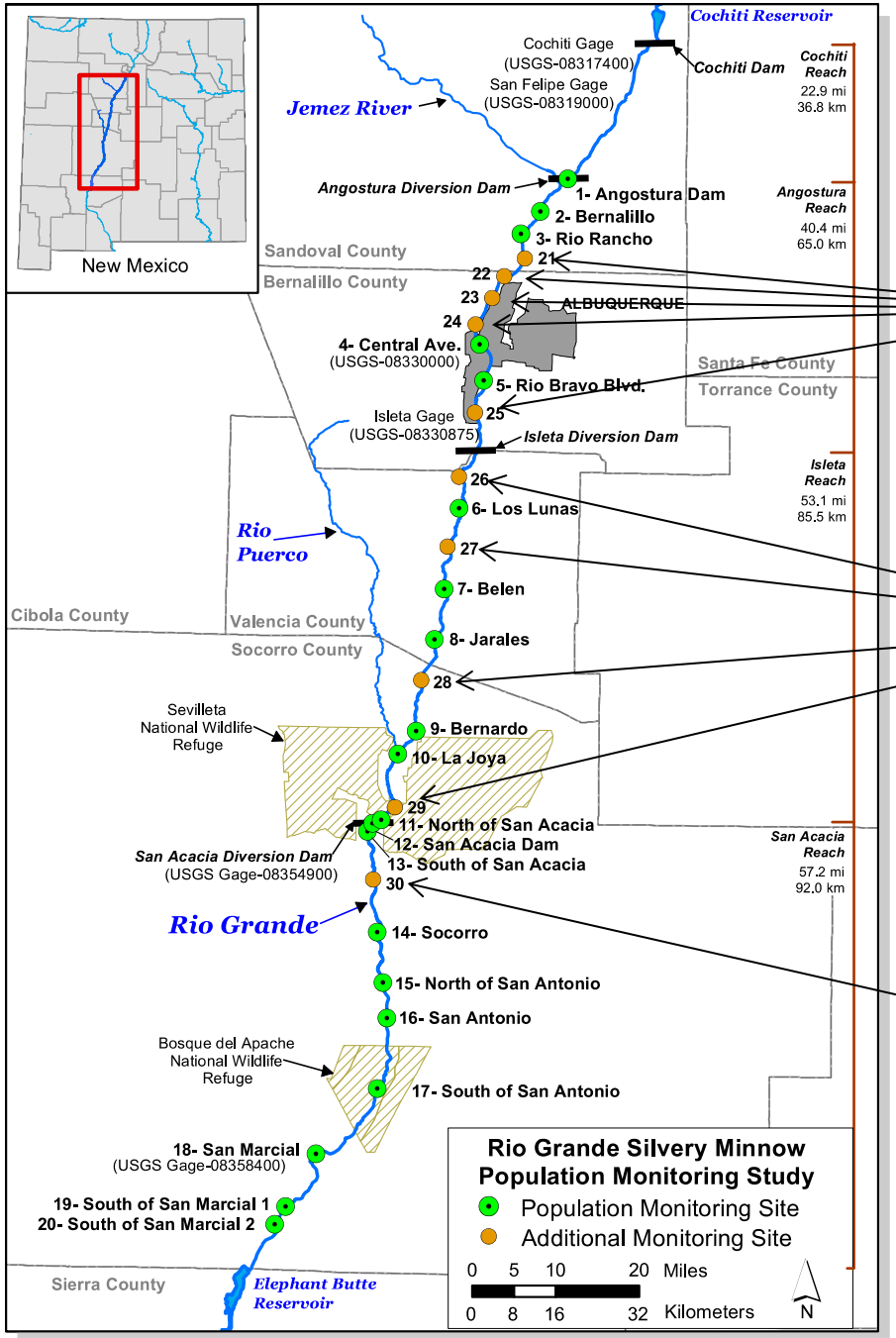


Angostura Reach sites (5)

Isleta Reach sites (6)

San Acacia Reach sites (9)

Additional Sites

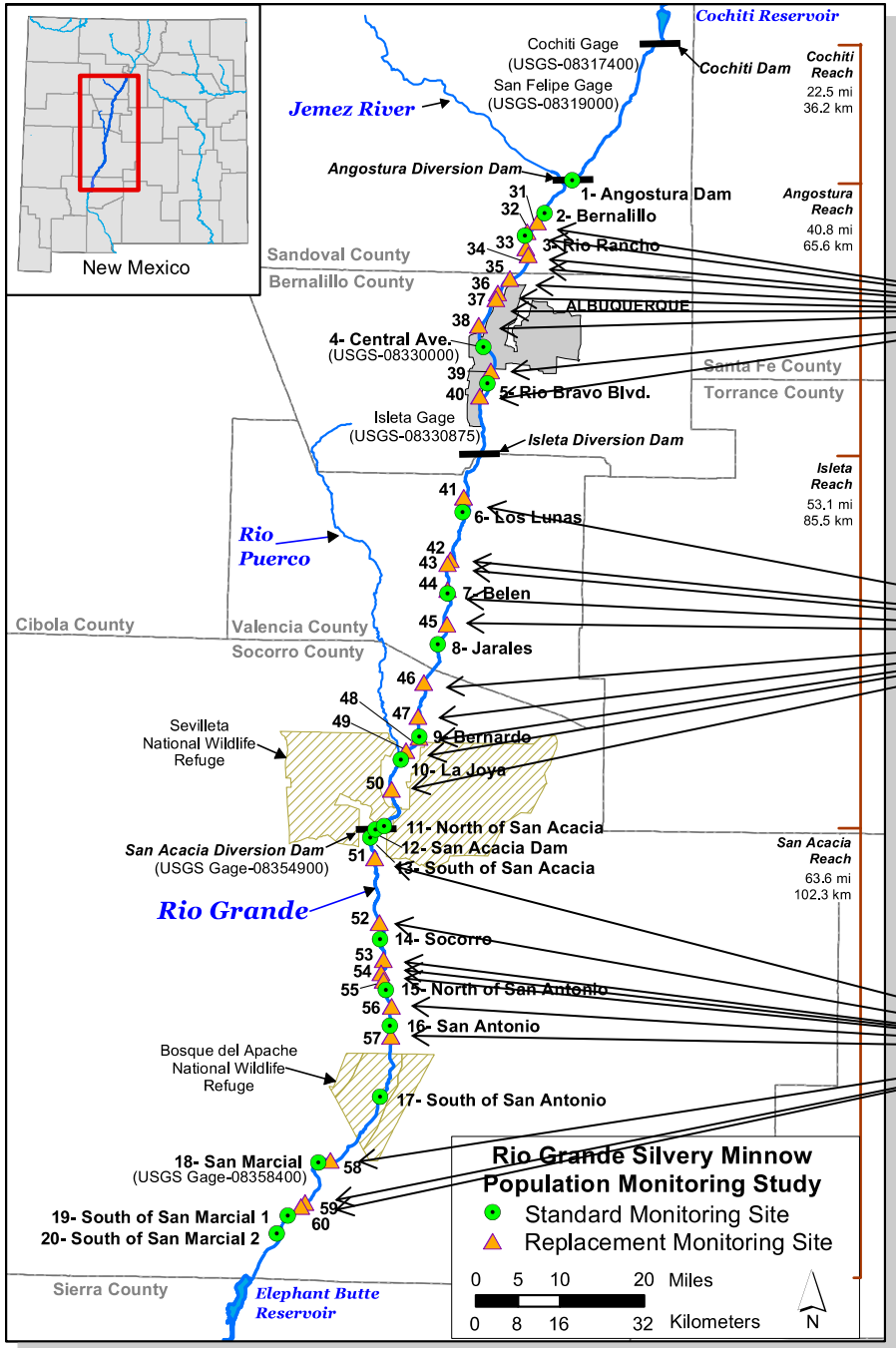


Angostura Reach sites
(5)

Isleta Reach sites
(4)

San Acacia Reach sites
(1)

Replacement Sites



Angostura Reach sites (10)

Isleta Reach sites (10)

San Acacia Reach sites (10)

Mesohabitats

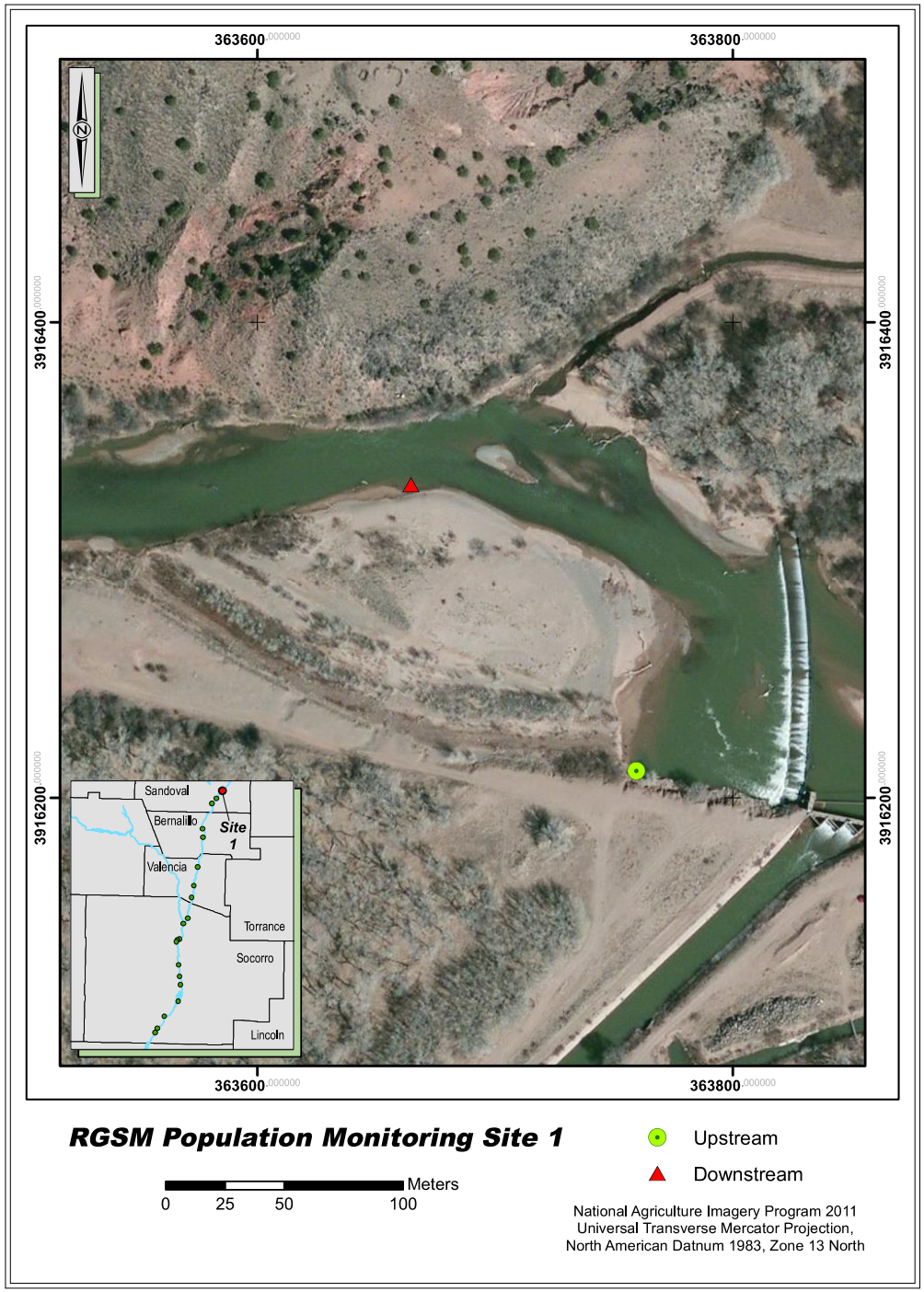
Runs
(RU)

Shoreline runs
(SHRU)

Backwaters
(BW)

Pools
(PO)

Shoreline pools
(SHPO)



Sampling Methods

Seine hauls by mesohabitat:

- (BW/PO = 2, RU/SHPO = 4)
- (SHRU = 6–14)

Adult fish seining:

- (3.1 m x 1.8 m; small mesh)

Larval fish seining:

- (1.0 m x 1.0 m; fine mesh)

Twenty seine hauls per site:

- Mesohabitats standardized
- Area sampled (ca. 500 m^2)

Evolution of Project Design

- The decline of RGSM during a prolonged drought (2000–2003), and formation of the MRGESCP, prompted notably increased sampling efforts.

- An external review, led by nationally-recognized experts, resulted in a workshop and a report (2004–2005).

- Most of the sampling recommendations and research studies, suggested by the experts, were initiated in 2006.

- The Population Monitoring Group (MRGESCP) produced a consensus report in 2006 on the desired protocols and objectives for this study.

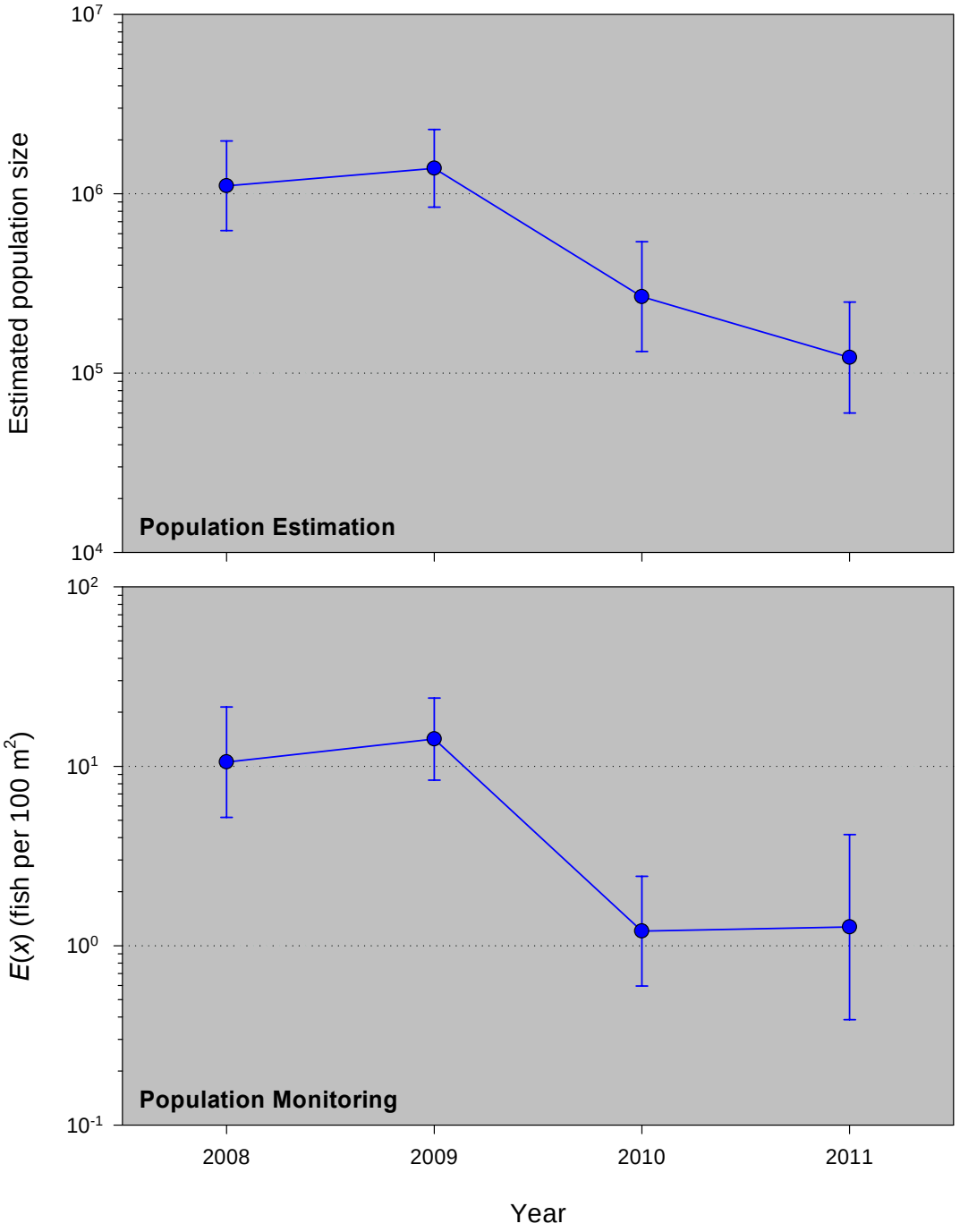
- The most recent external review, led by nationally-recognized experts, resulted in a workshop and a report (2015–2016), along with several recommendations for increased sampling efforts.

Population Trends
(Estimation vs. Monitoring)

- Similarities: Twenty sites, mesohabitats standardized, area sampled (ca. 500 m^2)

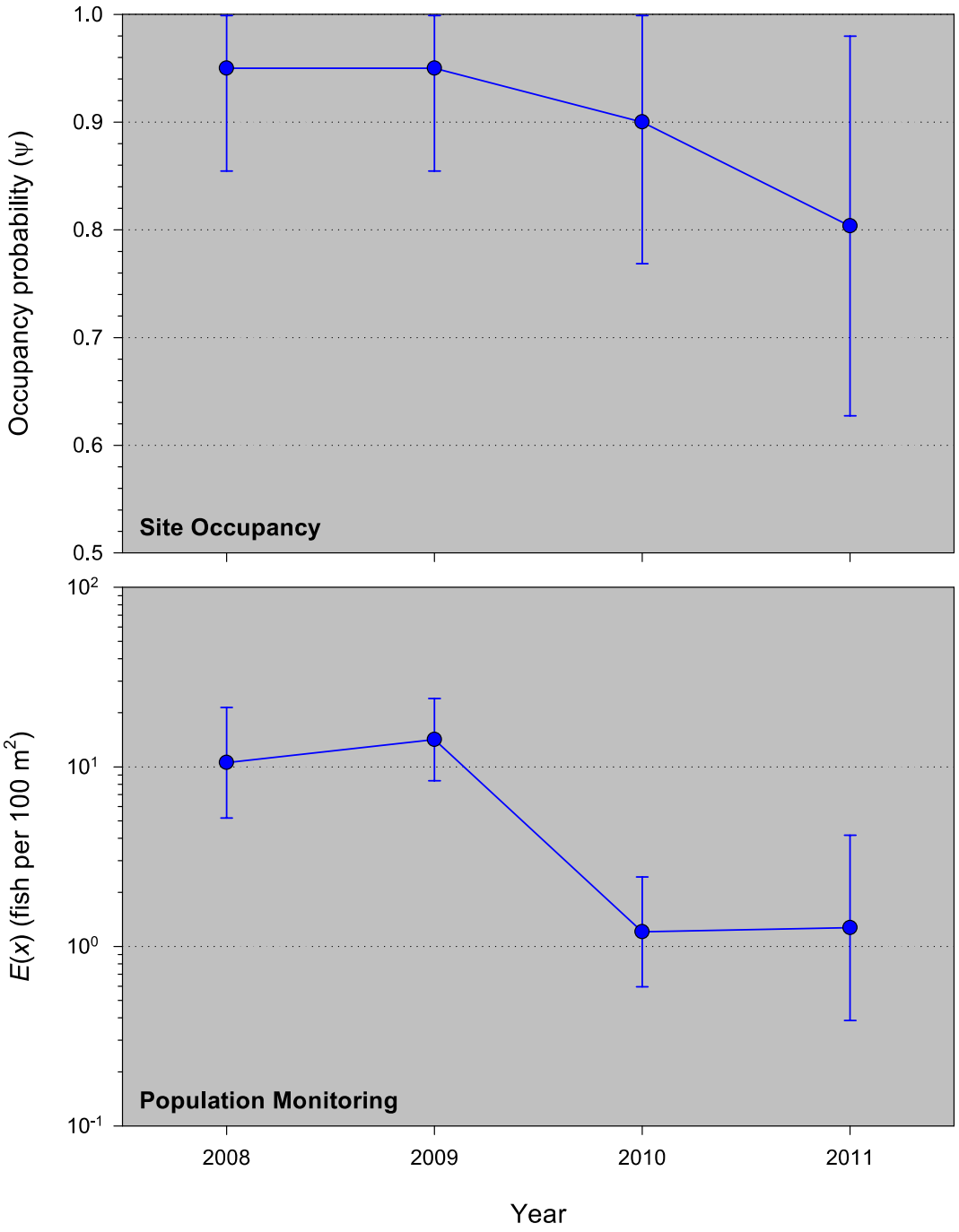
- Differences: Random sites and mesohabitats, mapping of mesohabitats and samples, electrofishing removal-sampling in enclosures

- Despite notable differences in methodology and required effort, both studies indicated very similar trends over time.



Population Trends
(Occupancy vs. Monitoring)

- Similarities: Twenty sites, mesohabitats standardized, area sampled (ca. 500 m^2)
- Differences: Sampled in November, same mesohabitats sampled repeatedly, sites were each sampled four times
- Despite notable differences in methodology and required effort, both studies indicated very similar trends over time.



Comparing Different Studies

Study strengths	Lower abundance	Higher abundance	Overall
Population monitoring	Early indication of decreased abundance and occurrence	Early indication of increased abundance and occurrence	Seasonal & annual trends in abundance and occurrence
Population estimation	Robust measure of decreased abundance	Robust measure of increased abundance	Robust estimate of annual abundance
Site occupancy	Robust measure of decreased occurrence (extinction)	Robust measure of increased occurrence (colonization)	Robust estimate of annual occurrence

Population Monitoring Objectives

- Determine trends in the occurrence and abundance of native and nonnative fishes, with a focus on Rio Grande Silvery Minnow (RGSM).

- Evaluate the influence of discharge (e.g., timing, magnitude, and duration) on RGSM population fluctuations.

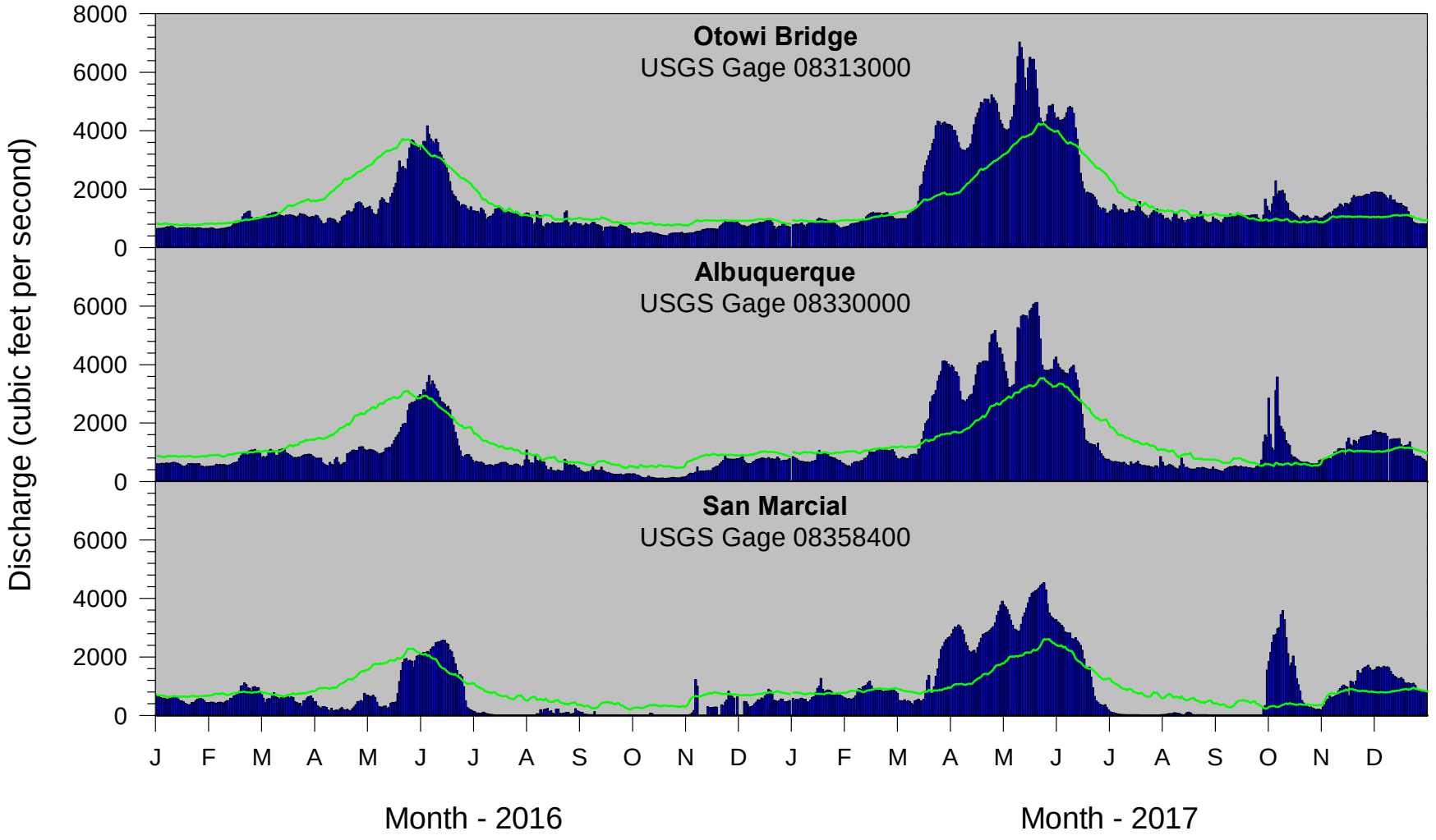
- Determine long-term trends in RGSM densities across different mesohabitats.

- Compare changes in RGSM relative and rank abundance to that of other native and nonnative fishes.

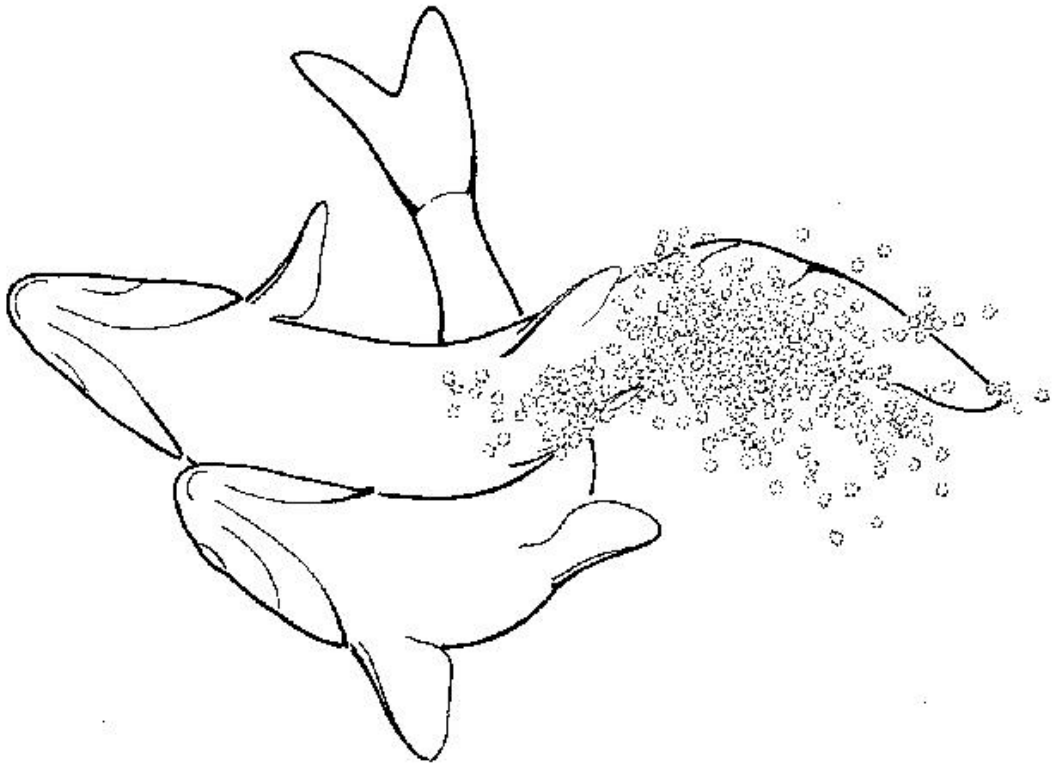
- Determine variation in RGSM densities and estimate their site occupancy rates based on repeated-sampling efforts.

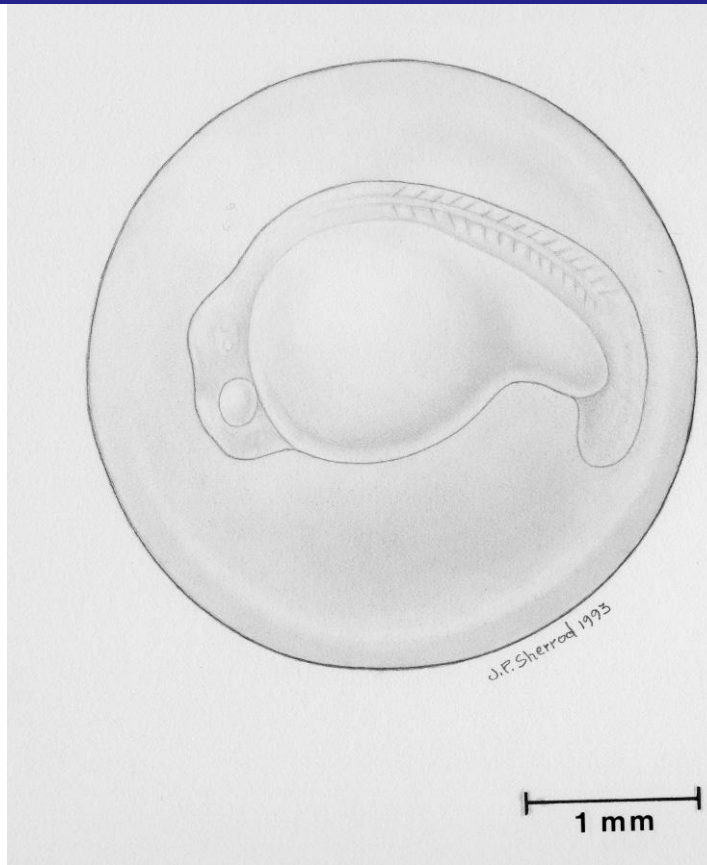
Population Monitoring Results (1993–2017)

Discharge in the Middle Rio Grande (2016/2017)

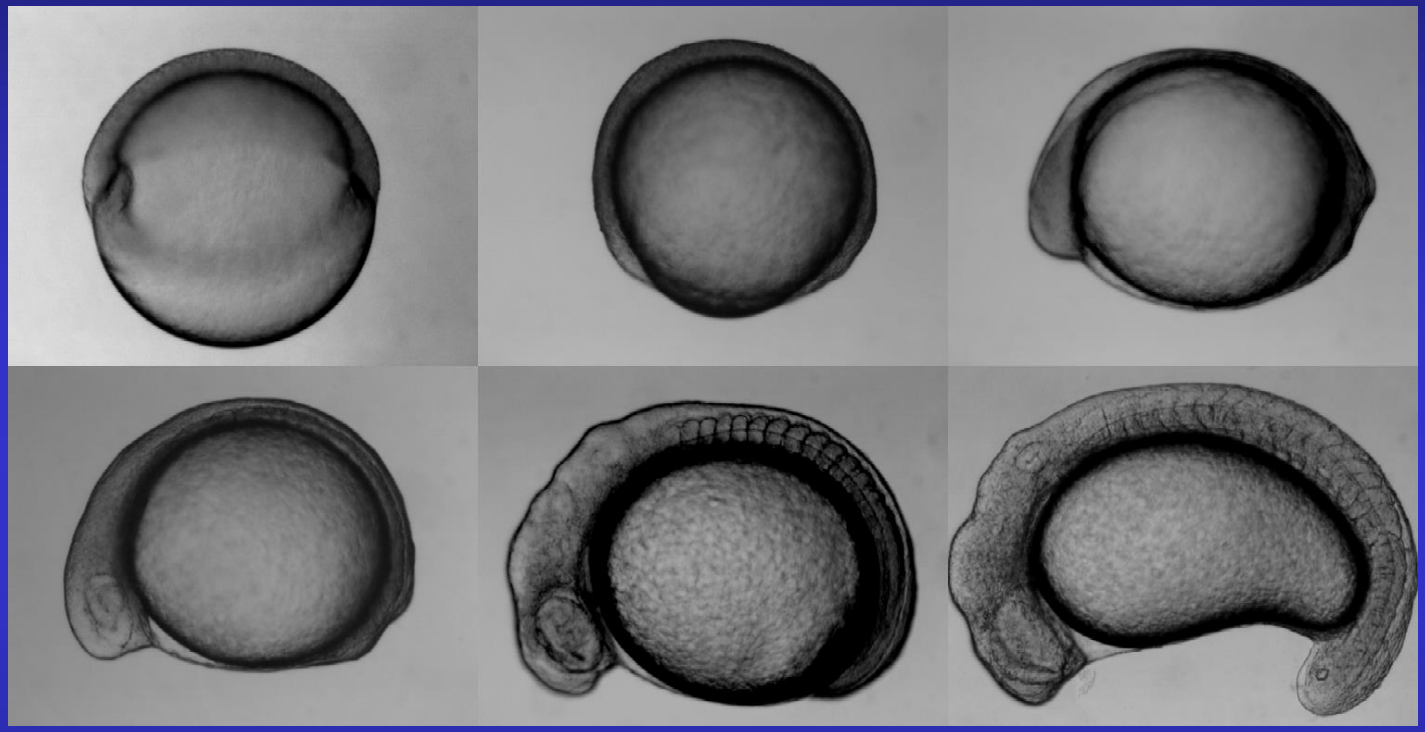


RGSM: Spawning and Eggs



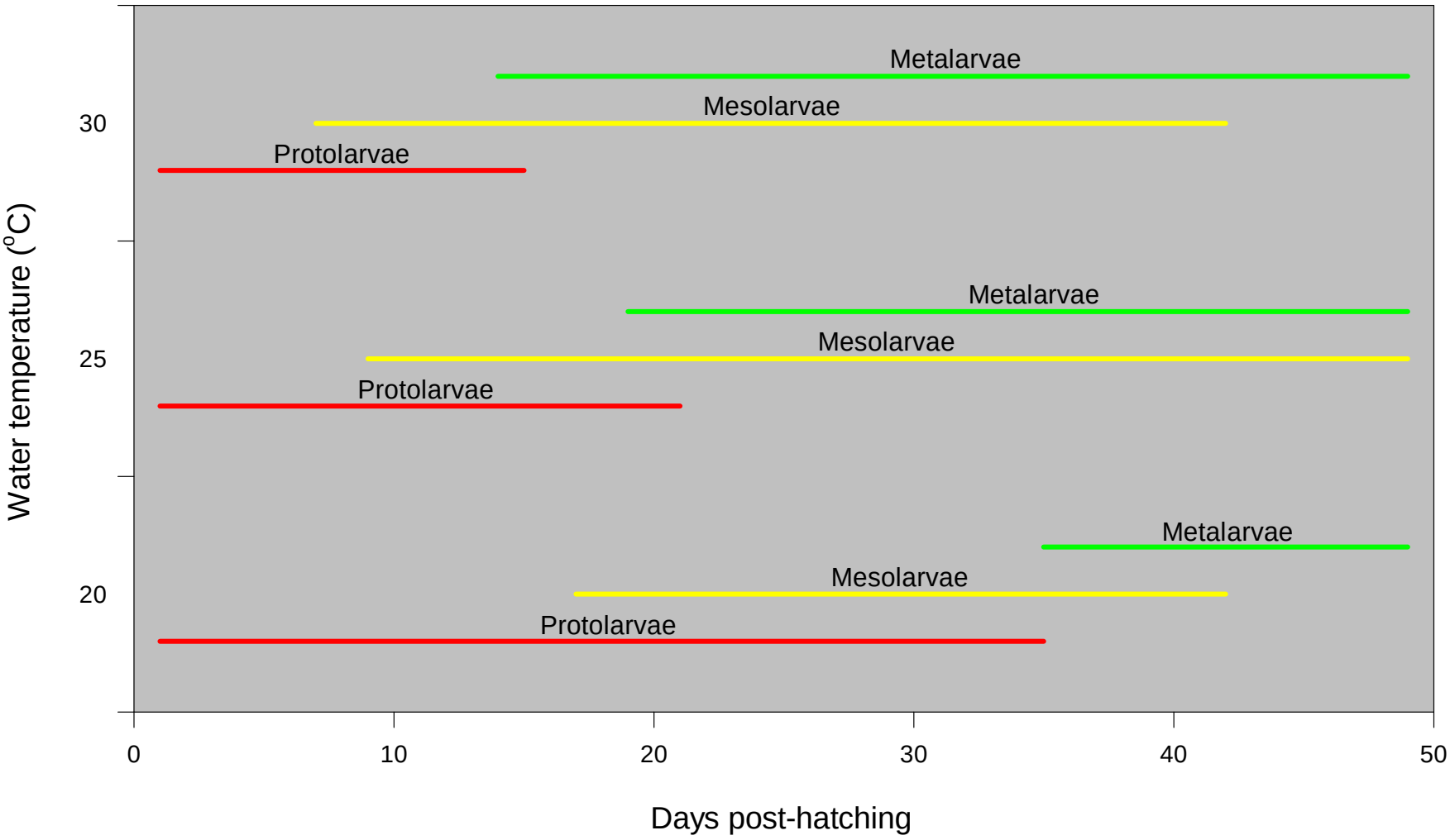


Egg Development and Hatching (Platania, 2000)

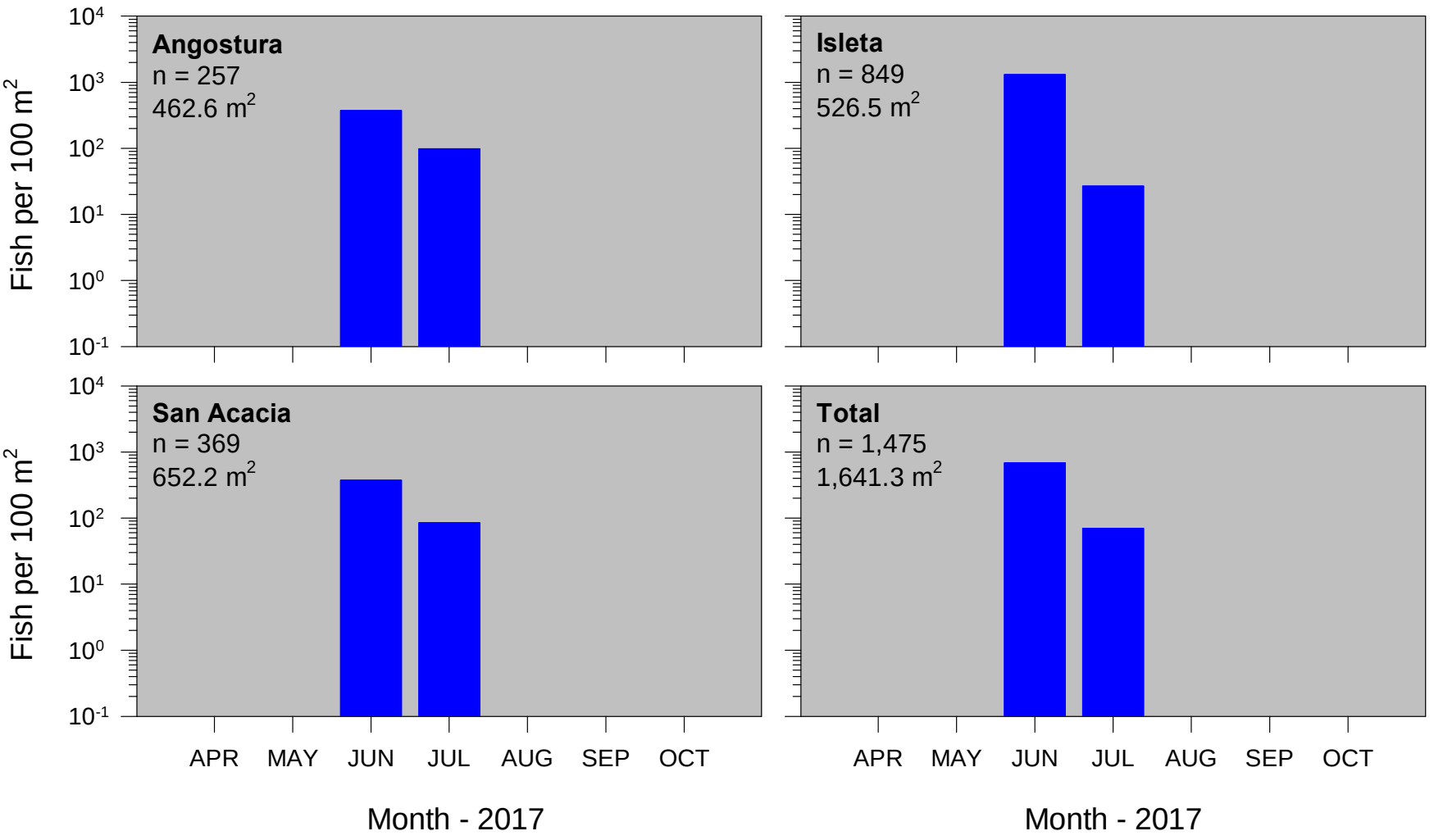


Water temperature	First hatch	Last hatch
30^{o} C	25 h	51 h
25^{o} C	35 h	51 h
20^{o} C	43 h	89 h

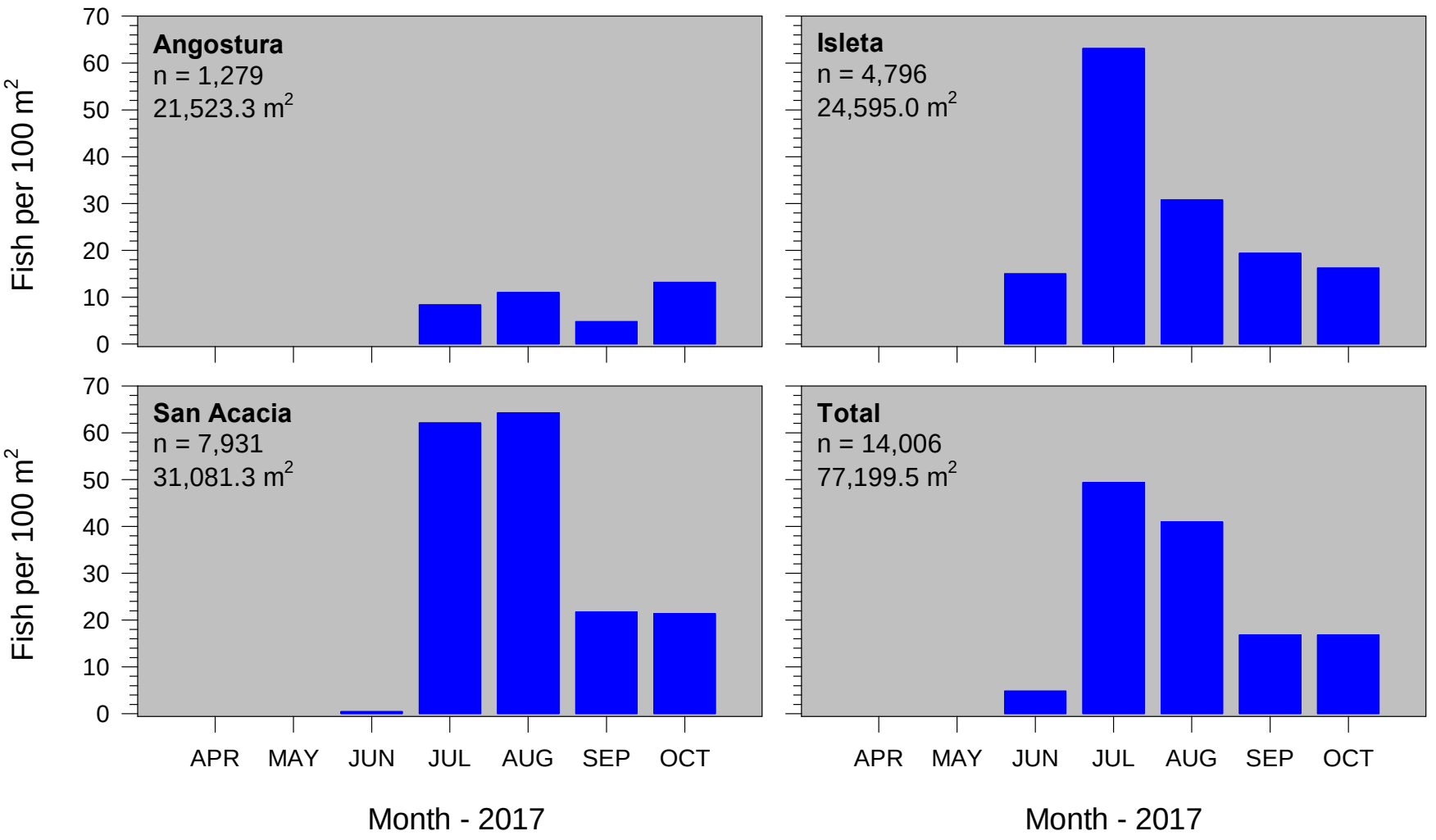
Fish Developmental Stages (Platania, 2000)



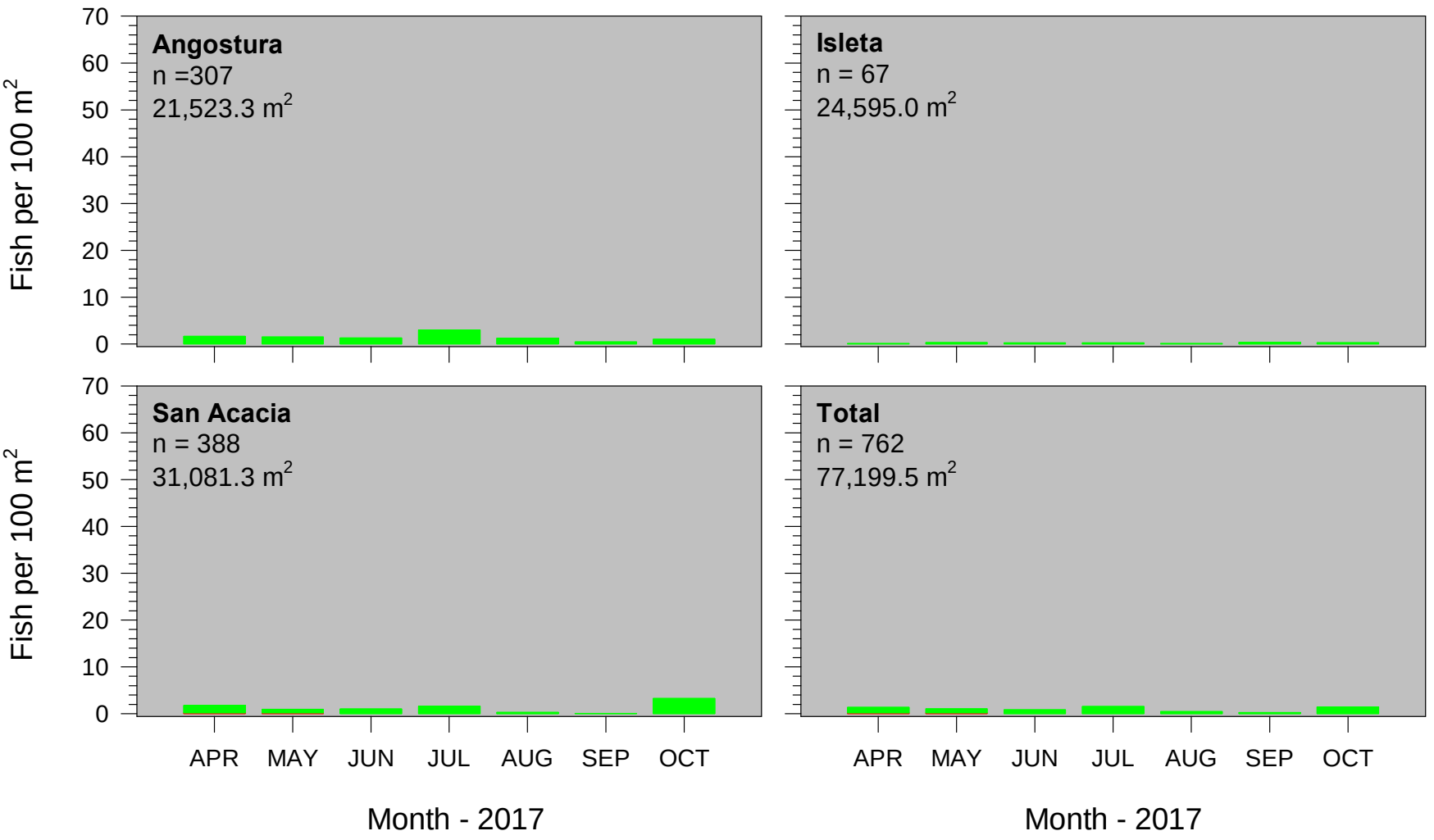
RGSM Population Trends in 2017 (Larval)



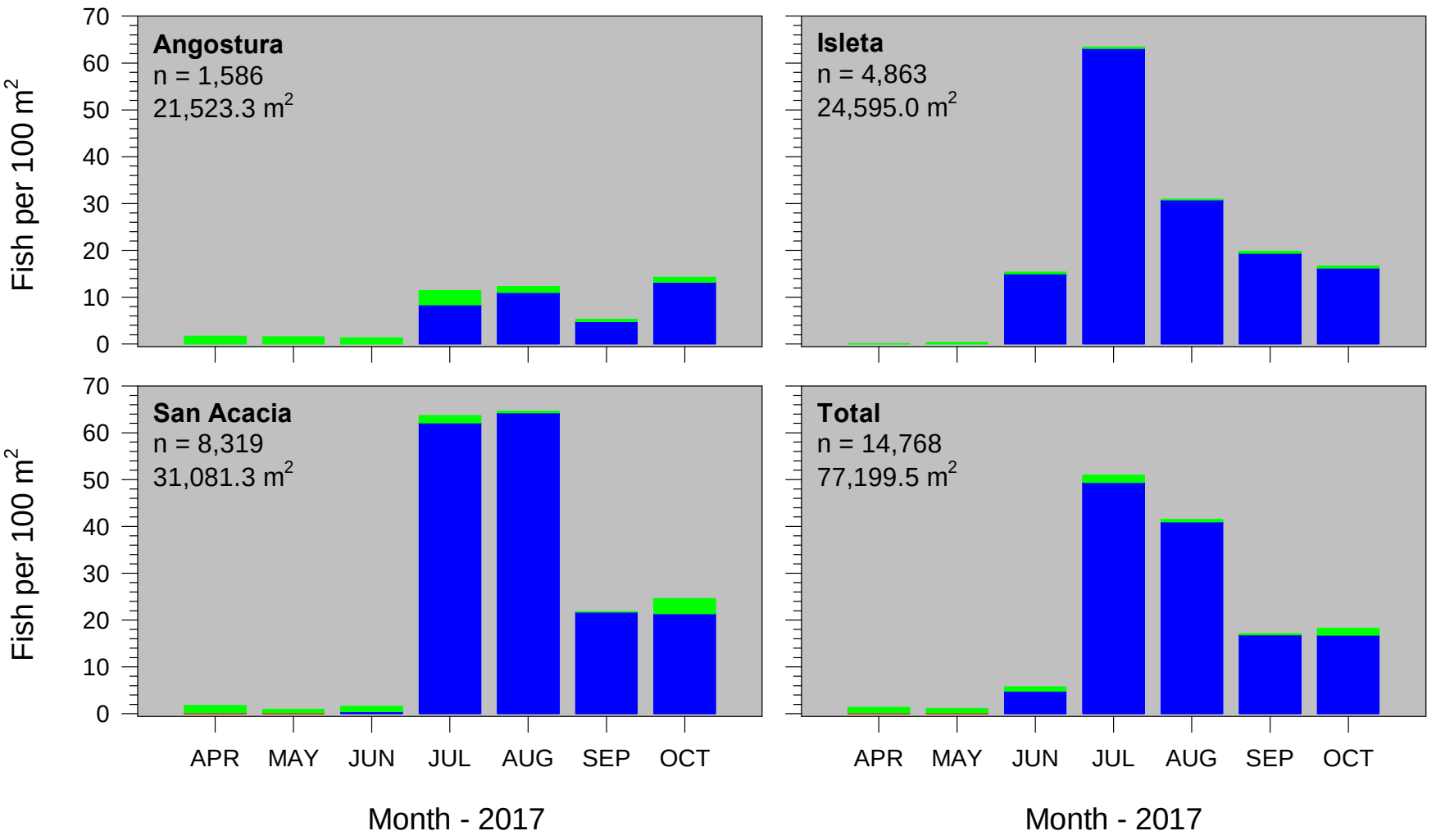
RGSM Population Trends in 2017 (Age-0)



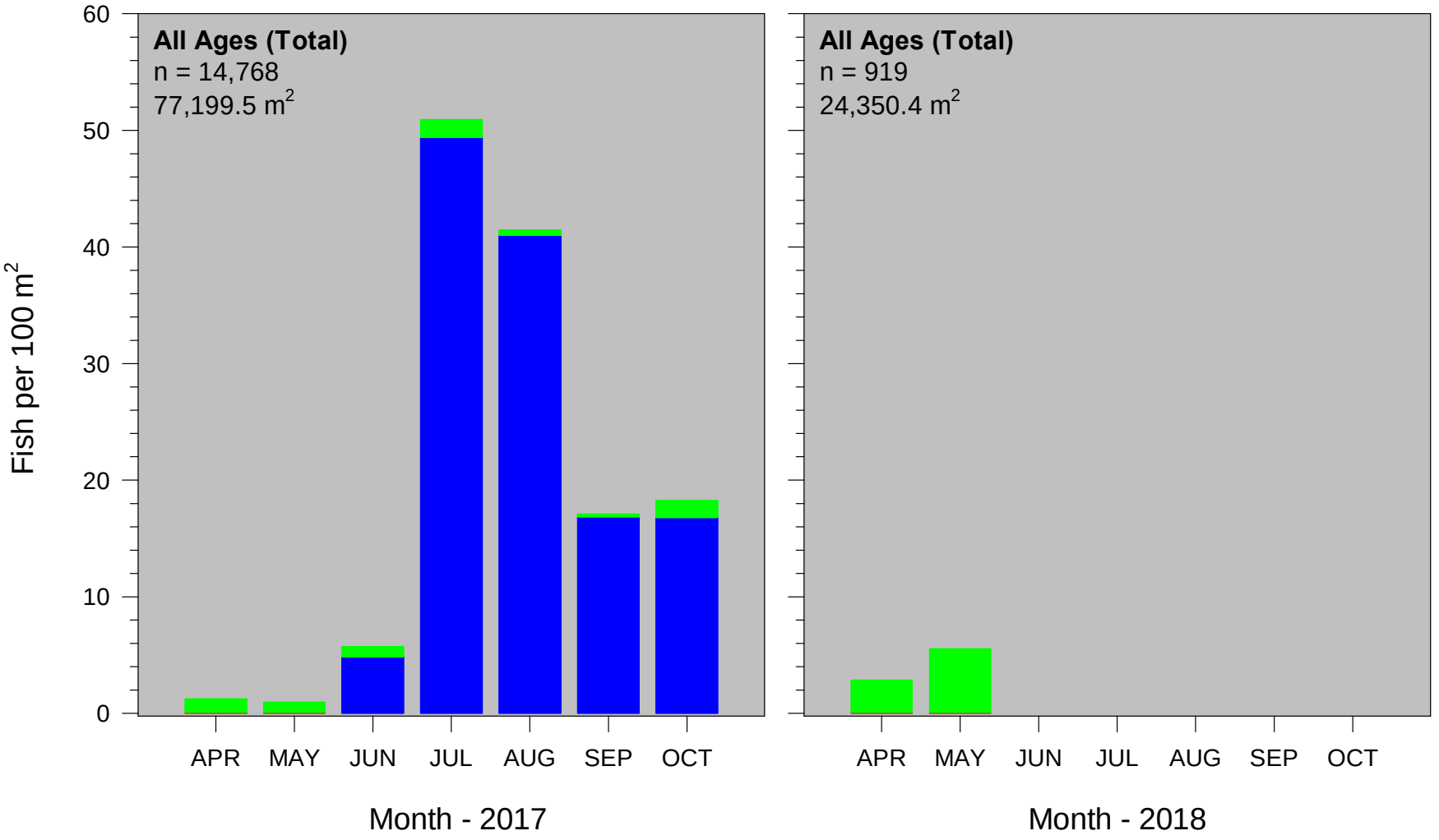
RGSM Population Trends in 2017 (Age-1+)



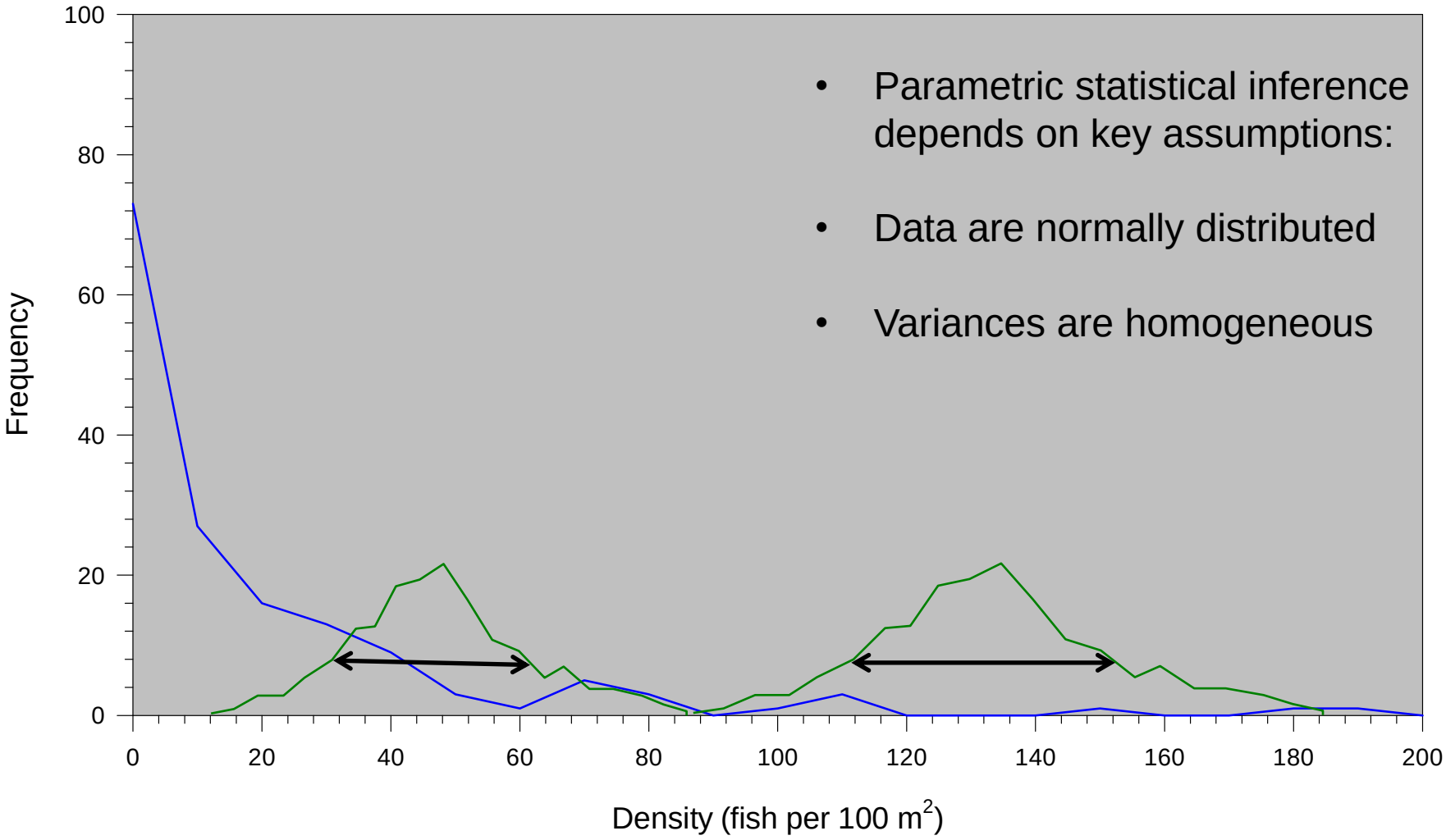
RGSM Population Trends in 2017 (All Ages)



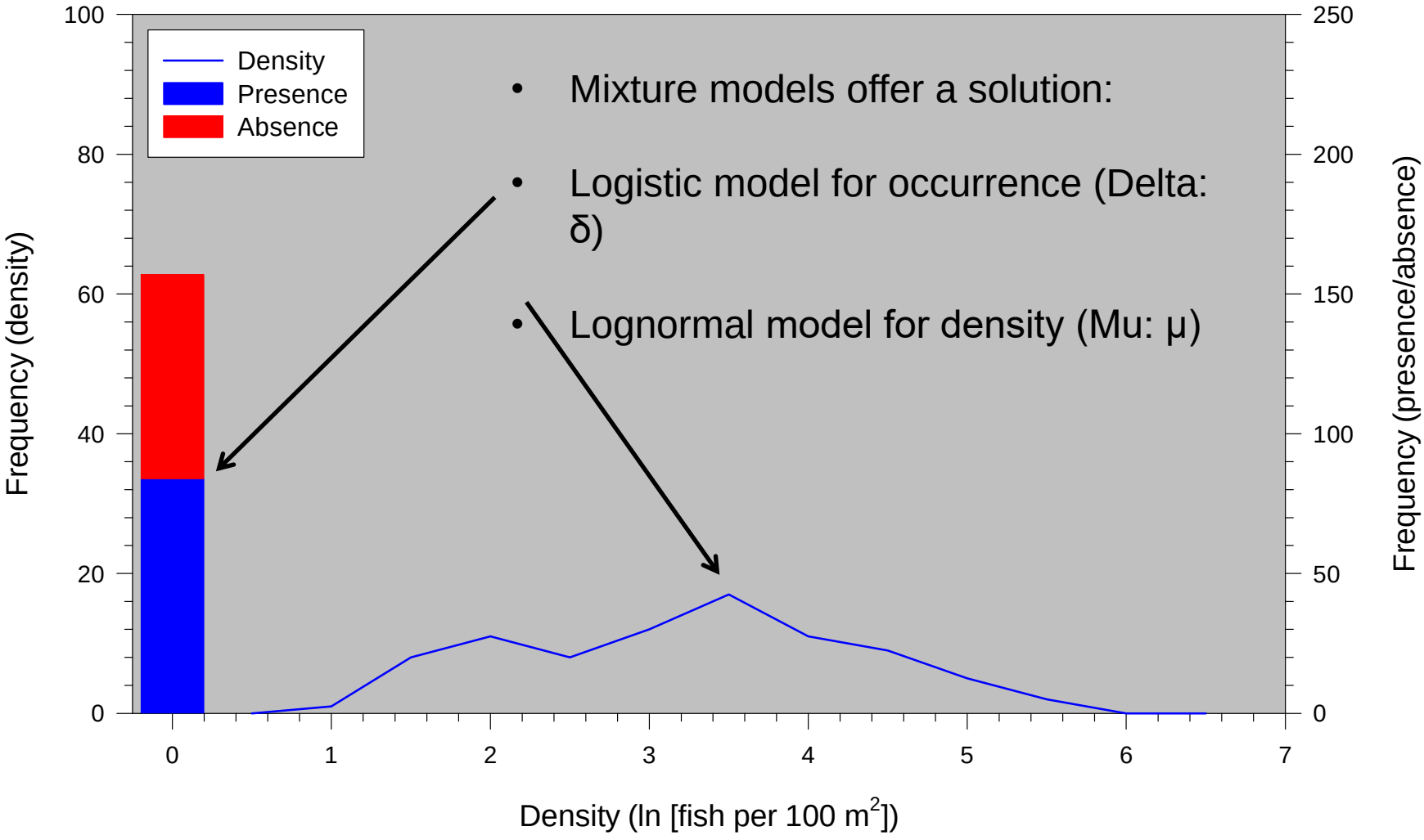
RGSM Population Trends in 2018 (Preliminary)



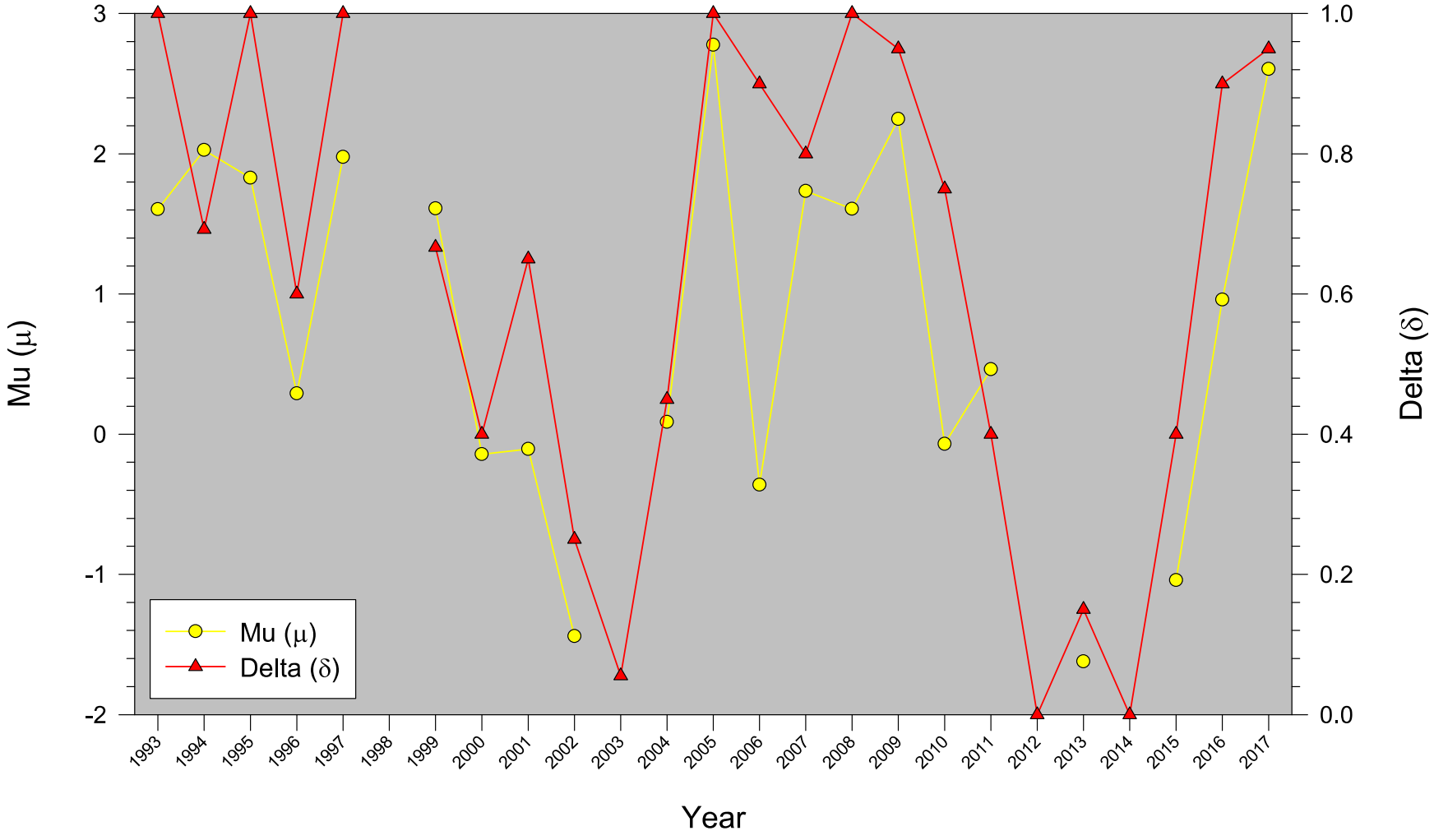
Frequency Distribution of Raw Data



Occurrence and Density Data



Model Estimates in October (1993–2017)



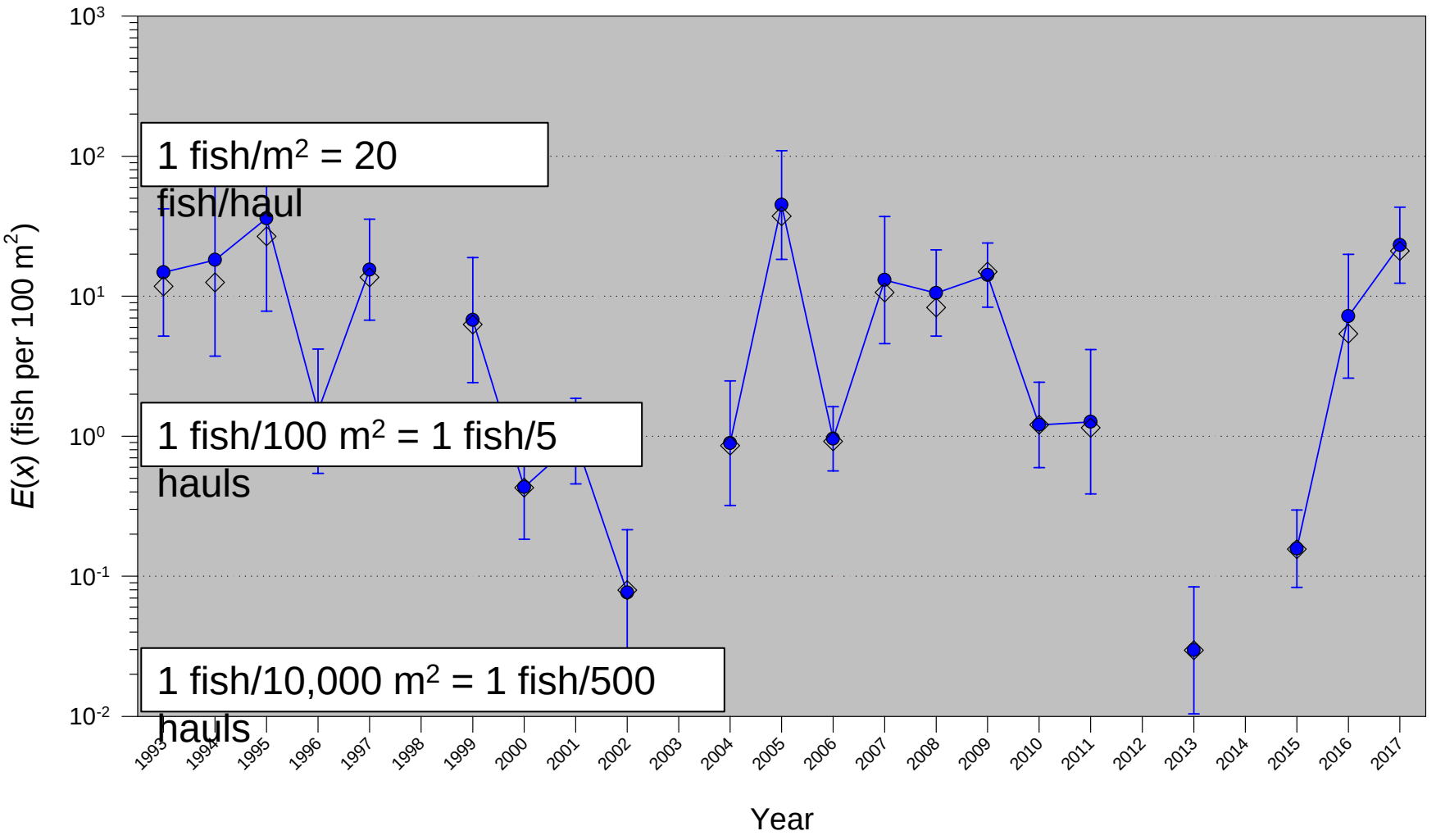
Computing the Expected Density

$$E(x) = \delta \exp\left(\mu + \frac{\sigma^2}{2}\right)$$

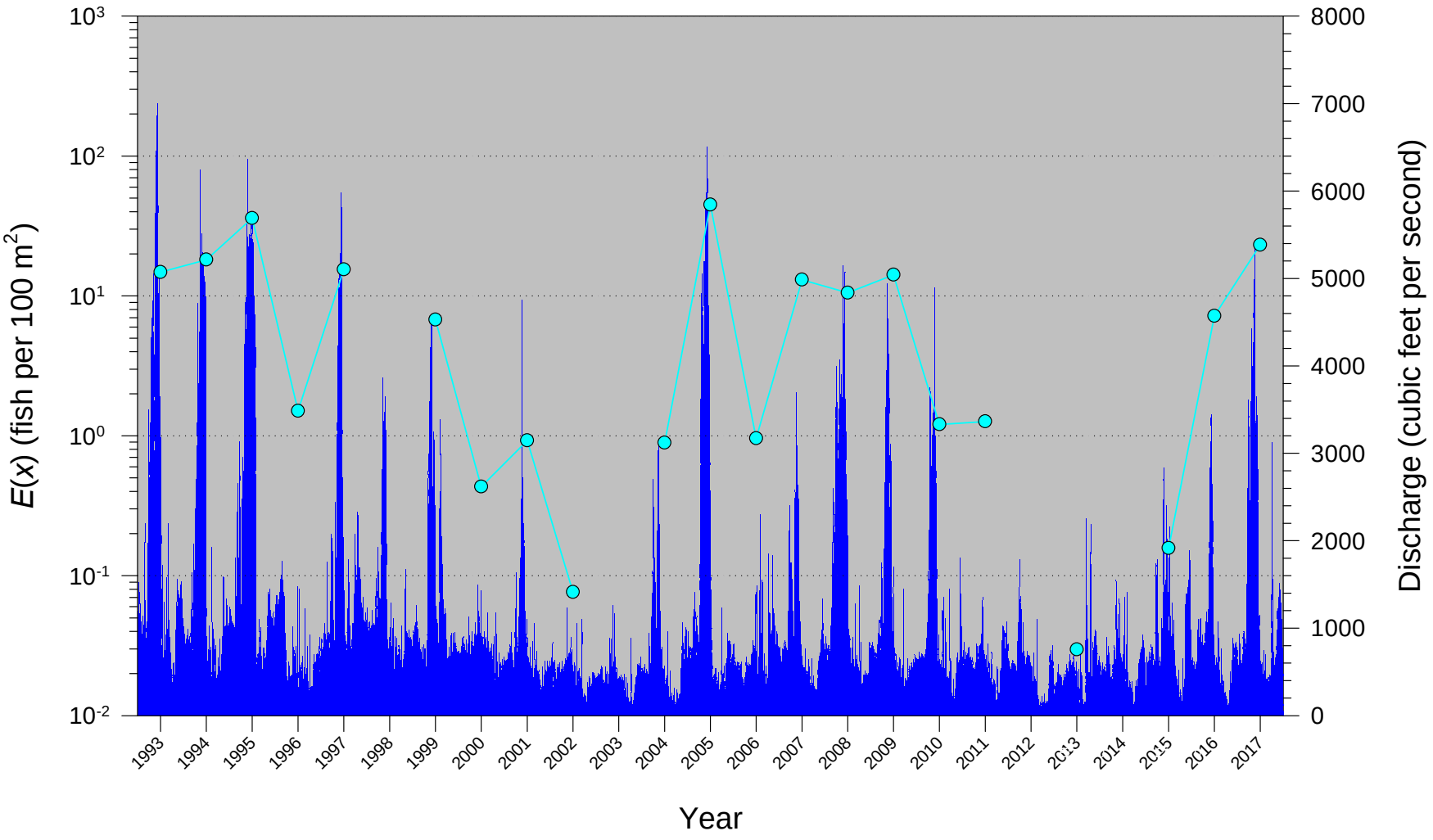
$$\text{LCI} = \exp\left[\log\left(E(x)\right) - 1.96 \times \text{SE}\left(E(x)\right) / E(x)\right]$$

$$\text{UCI} = \exp\left[\log\left(E(x)\right) + 1.96 \times \text{SE}\left(E(x)\right) / E(x)\right]$$

Densities of RGSM in October (1993–2017)



Densities of RGSM and Discharge (1993–2017)



Modeling the Ecology of RGSM

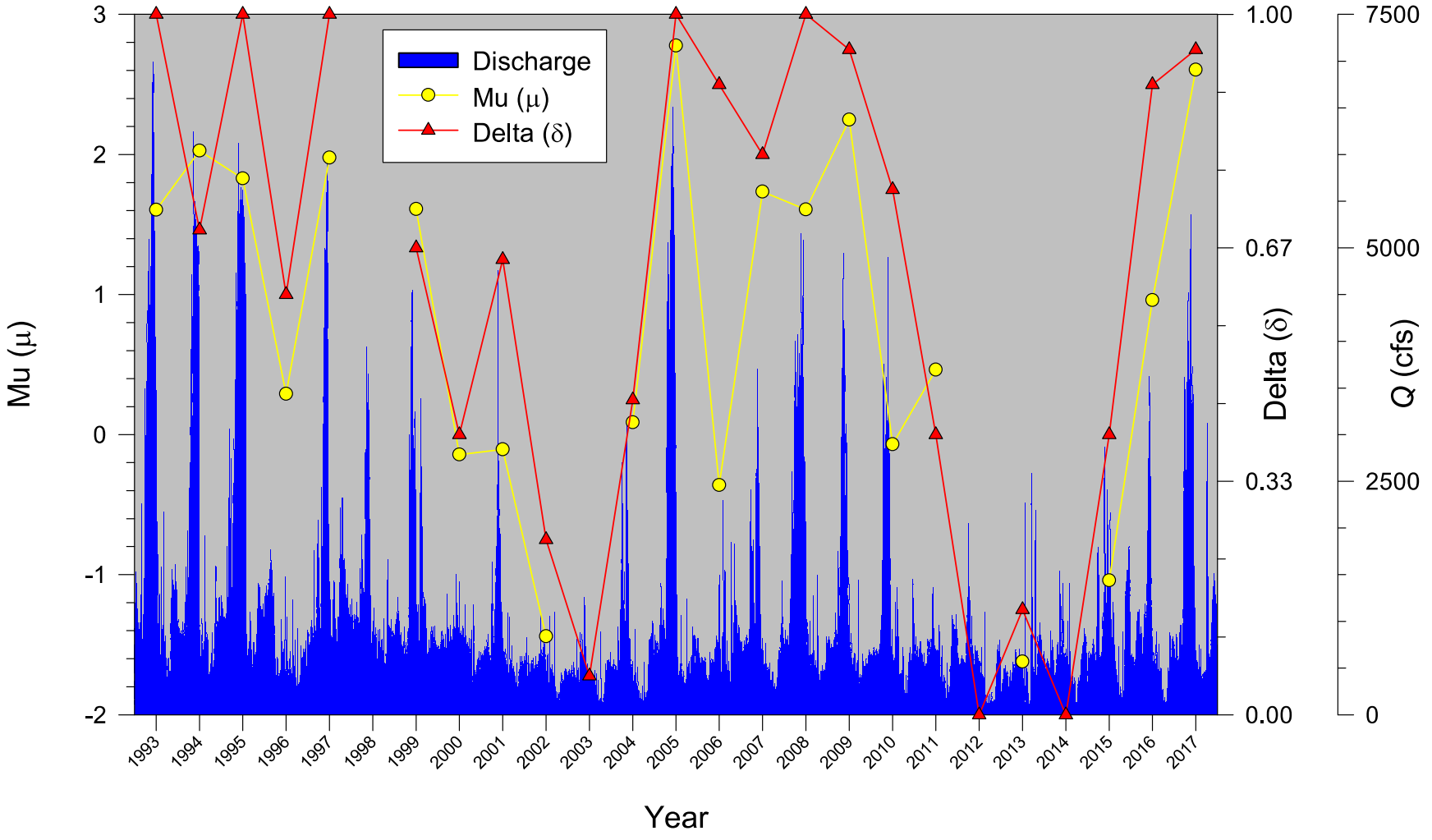
- Each model included both δ and μ with a single covariate for each estimated parameter (e.g., δ[SAN<200] μ[ABQ>3,000]).

- Covariates representing spring runoff conditions, estimated floodplain inundation, and summer low flow conditions were included in models.

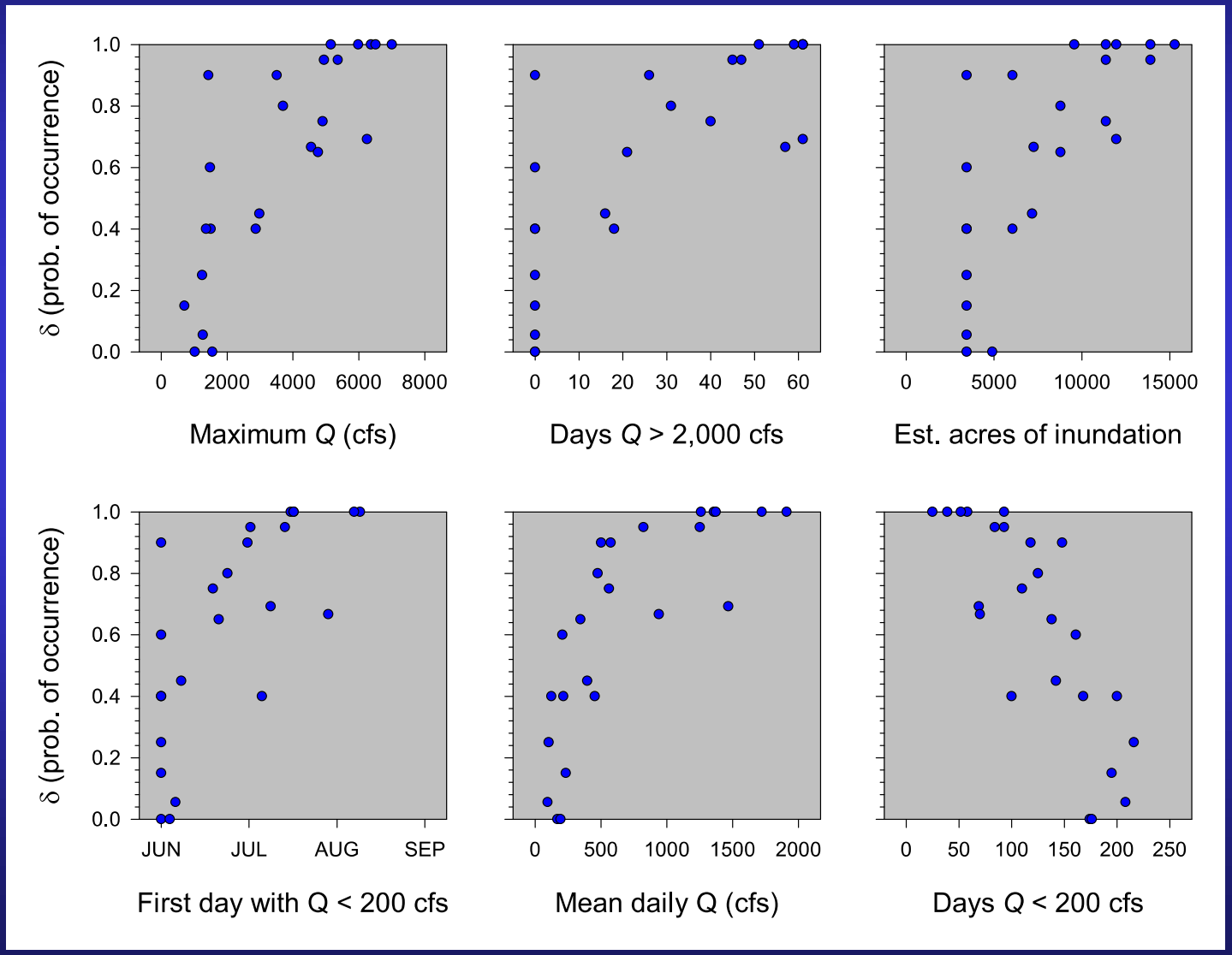
- Hydraulic covariates included both fixed effects (i.e., covariate explains variation) and random effects (i.e., random error [*R*] around covariate).

- Goodness-of-fit statistics (log-likelihood and Akaike's information criterion [AIC_C]) were used to assess the fit of data to various models.

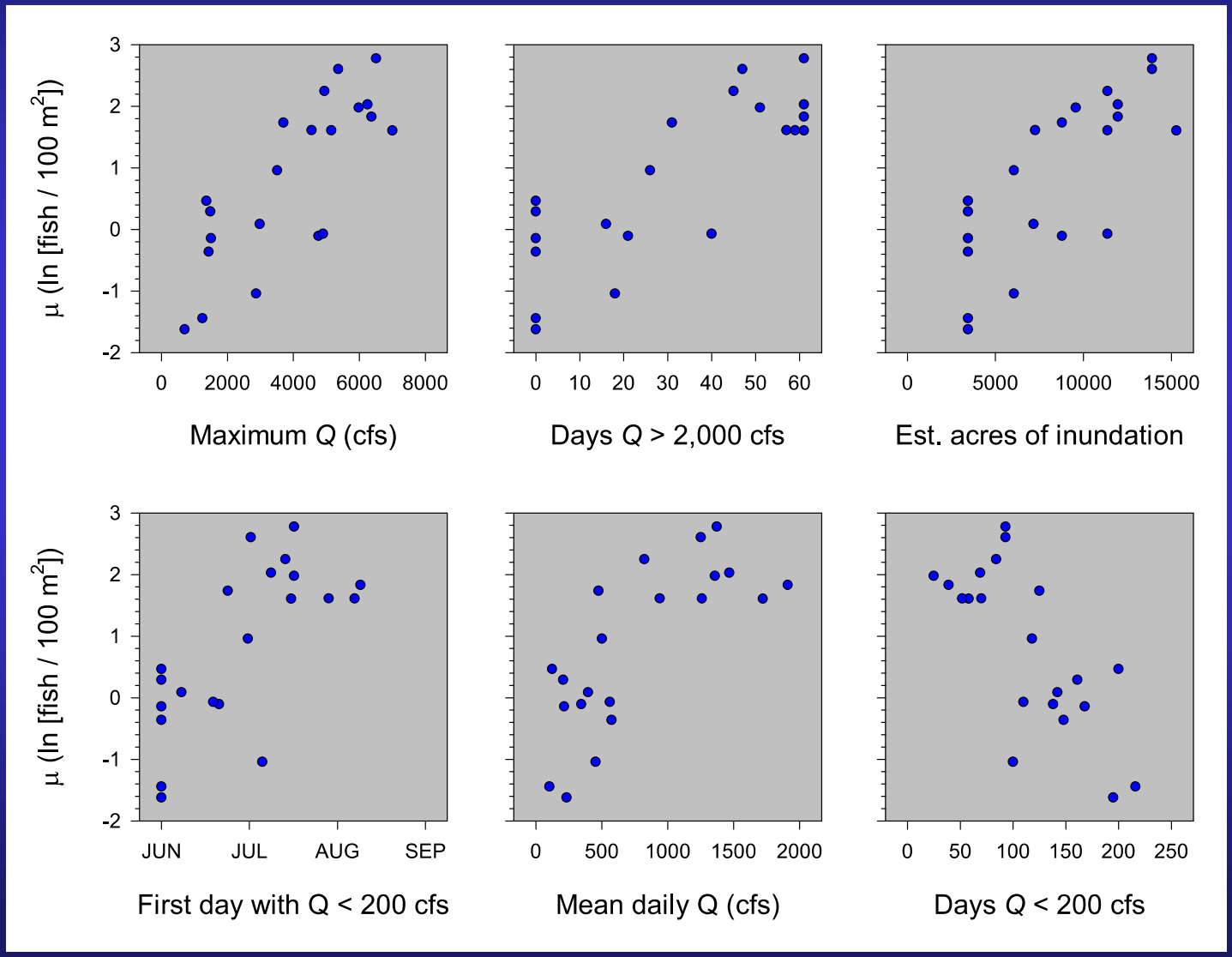
Model Estimates and Discharge (1993–2017)



Occurrence Probability vs. Discharge (1993–2017)



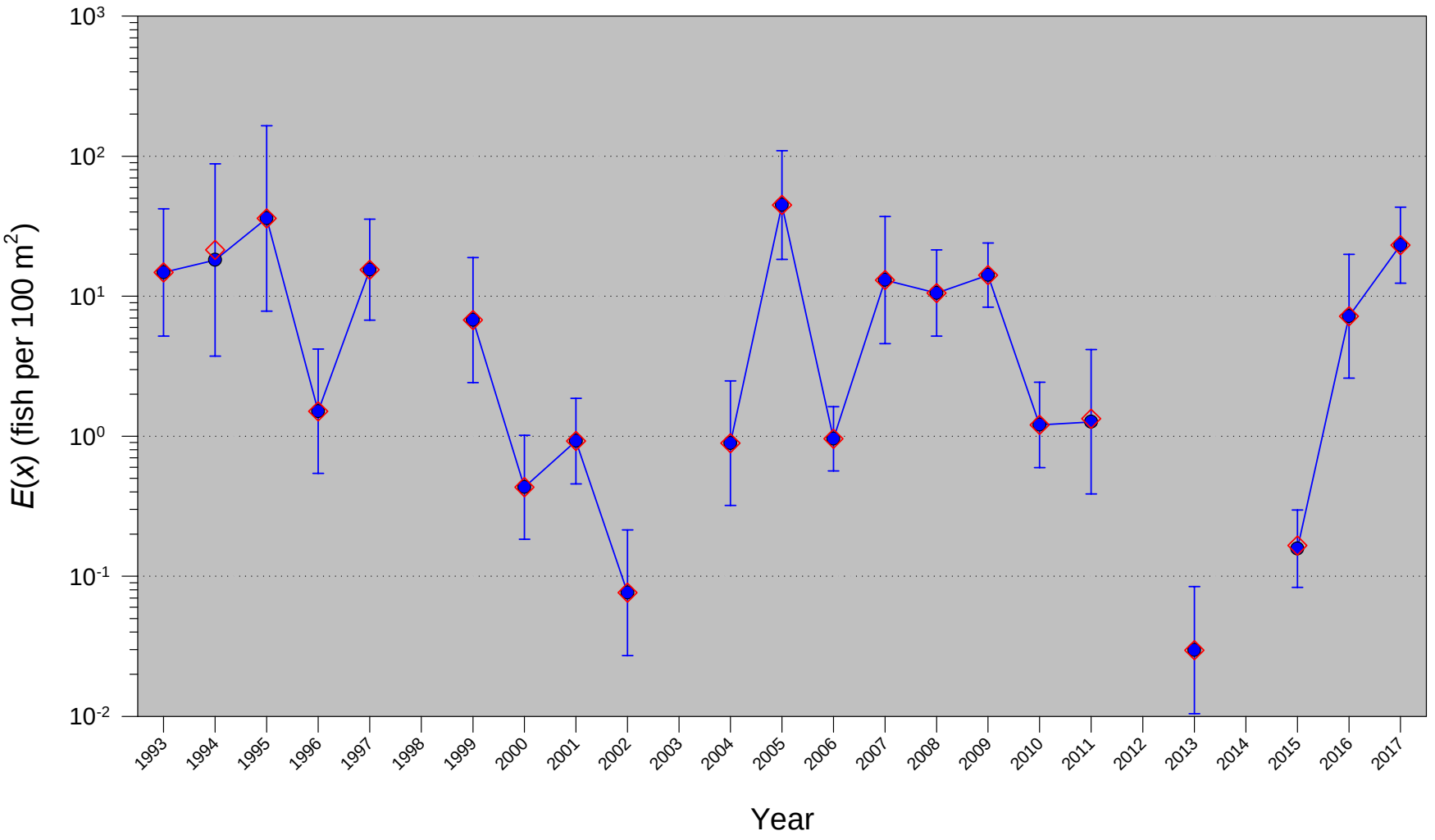
Lognormal Densities vs. Discharge (1993–2017)



Ecological Model Results for RGSM (1993–2017)

Model	logLike	K	AIC_C	w_i
δ(Year) μ(ABQ>2,000+*R*)	744.93	29	807.14	0.5841
δ(Year) μ(ABQ>3,000+*R*)	746.99	29	809.20	0.2084
δ(Year) μ(ABQmax+*R*)	748.29	29	810.50	0.1089
δ(Year) μ(SANmean+*R*)	750.17	29	812.38	0.0426
δ(Year) μ(ABQ>1,000+*R*)	750.93	29	813.14	0.0291
δ(Year) μ(Inundation+*R*)	754.09	29	816.30	0.0060
δ(Year) μ(SAN<200+*R*)	754.21	29	816.42	0.0056
δ(Year) μ(SAN1stday<200+*R*)	755.08	29	817.29	0.0036
δ(Year) μ(SAN<100+*R*)	755.31	29	817.53	0.0032
δ(SAN<200+*R*) μ(ABQ>2,000+*R*)	799.96	9	818.38	0.0021

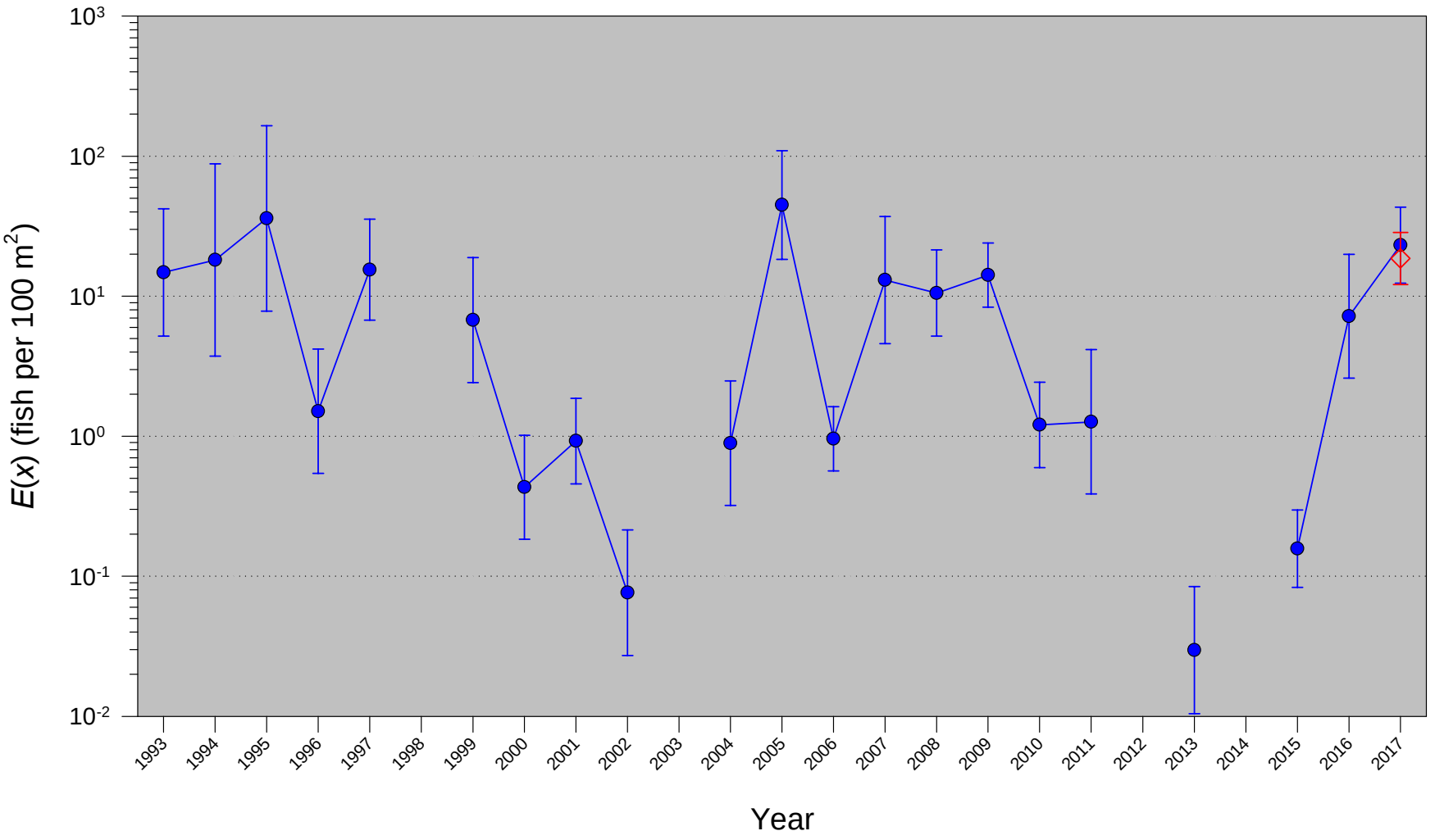
Densities of RGSM in October (No Dry Sites)



Ecological Model Results for RGSM (No Dry Sites)

Model	logLike	K	AIC_C	w_i
δ(Year) μ(ABQ>2,000+*R*)	737.20	29	799.51	0.5532
δ(Year) μ(ABQ>3,000+*R*)	739.26	29	801.57	0.1975
δ(Year) μ(ABQmax+*R*)	740.56	29	802.86	0.1032
δ(Year) μ(SANmean+*R*)	742.44	29	804.74	0.0403
δ(Year) μ(ABQ>1,000+*R*)	743.20	29	805.50	0.0276
δ(SANmean+*R*) μ(ABQ>2,000+*R*)	787.62	9	806.05	0.0210
δ(SANmean+*R*) μ(ABQ>3,000+*R*)	788.94	9	807.36	0.0109
δ(SAN<200+*R*) μ(ABQ>2,000+*R*)	788.99	9	807.41	0.0106
δ(ABQmax+*R*) μ(ABQ>2,000+*R*)	790.01	9	808.44	0.0064
δ(Year) μ(Inundation+*R*)	746.35	29	808.66	0.0057

Densities of RGSM in October (Additional Sites)



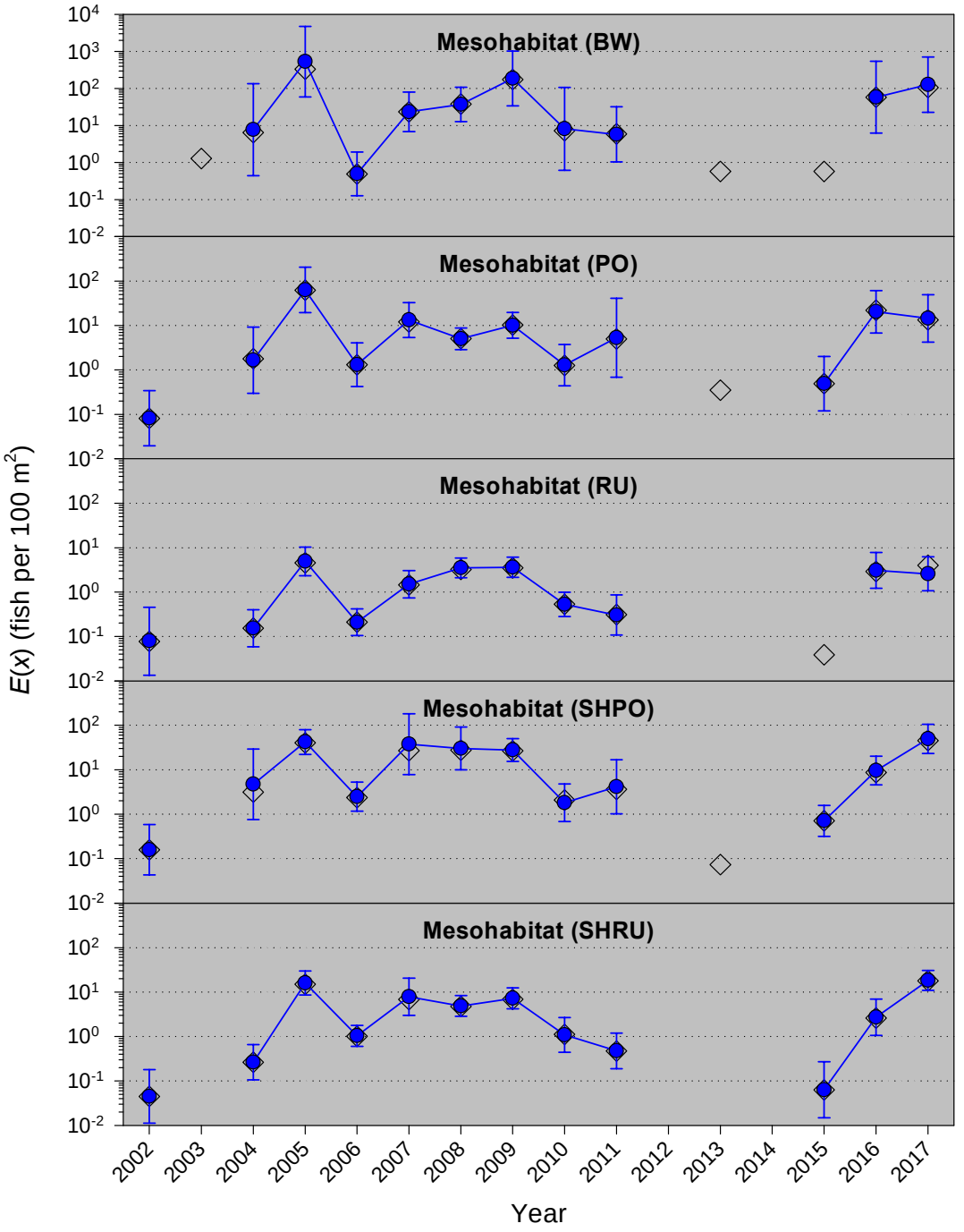
Ecological Model Results for RGSM (Additional Sites)

Model	logLike	K	AIC_C	w_i
δ(Year) μ(ABQ>2,000+*R*)	754.15	29	816.26	0.6062
δ(Year) μ(ABQ>3,000+*R*)	756.41	29	818.52	0.1957
δ(Year) μ(ABQmax+*R*)	757.67	29	819.79	0.1039
δ(Year) μ(SANmean+*R*)	759.88	29	821.99	0.0346
δ(Year) μ(ABQ>1,000+*R*)	760.38	29	822.49	0.0269
δ(Year) μ(SAN<200+*R*)	762.96	29	825.08	0.0074
δ(Year) μ(SAN1stday<200+*R*)	763.37	29	825.49	0.0060
δ(Year) μ(SAN<100+*R*)	763.46	29	825.57	0.0058
δ(Year) μ(Inundation+*R*)	764.49	29	826.61	0.0034
δ(SAN<200+*R*) μ(ABQ>2,000+*R*)	809.08	9	827.49	0.0022

Densities of RGSM
(Mesohabitats)

- Mesohabitat-specific density trends were very similar to the overall long-term trend.

- Estimated densities in BW, PO, and SHPO were generally higher and more variable as compared to SHRU or RU.



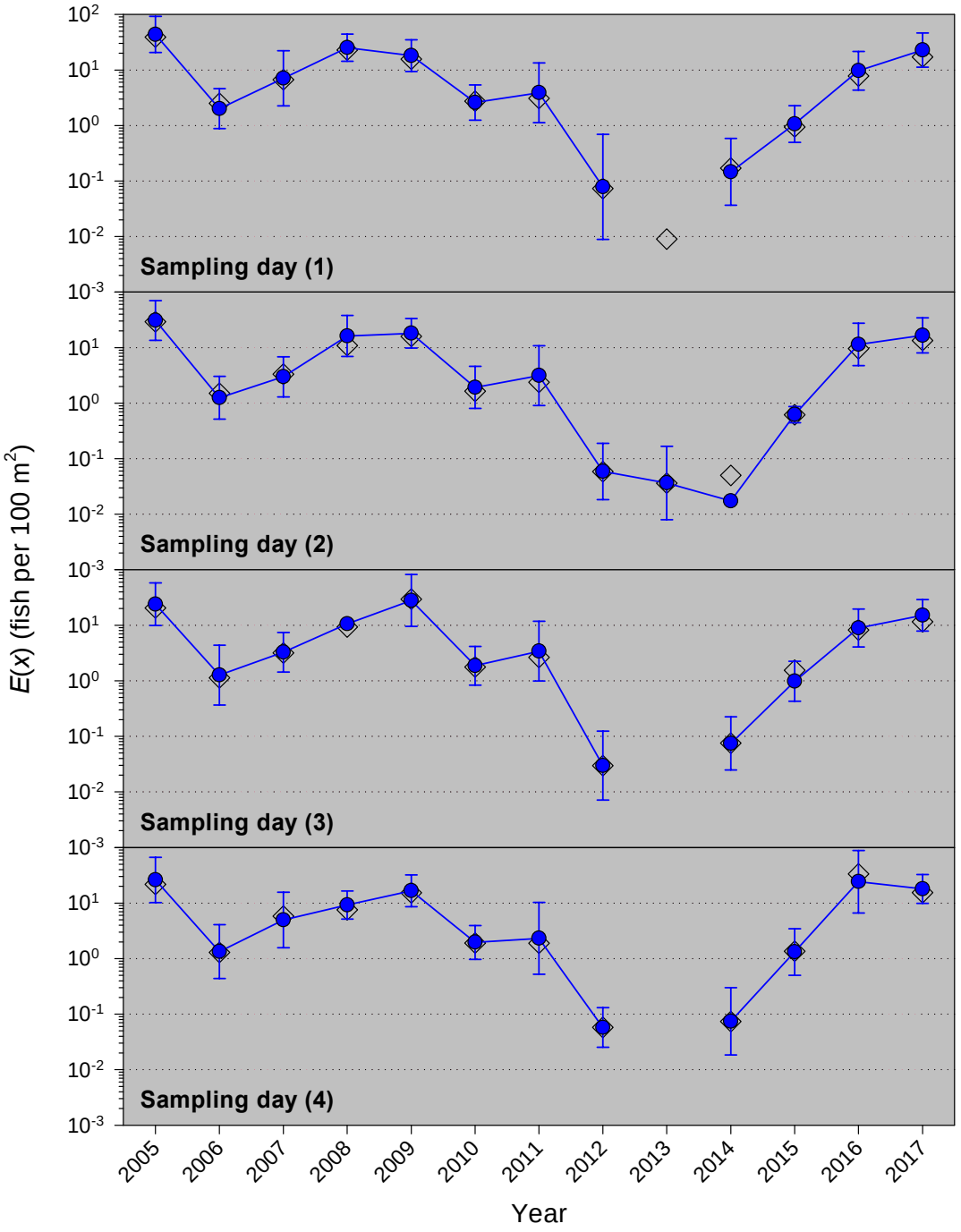
Mesohabitat Model Results for RGSM (2002–2017)

Model	logLike	K	AIC_C	w_i
δ(Year+Mesohabitat) μ(Year+Mesohabitat)	1,768.73	60	1,894.34	>0.9999
δ(Year) μ(Year+Mesohabitat)	1,808.28	56	1,925.15	<0.0001
δ(Year+Mesohabitat) μ(Mesohabitat)	1,991.67	30	2,053.06	<0.0001
δ(Year) μ(Mesohabitat)	2,029.88	26	2,082.93	<0.0001
δ(Year+Mesohabitat) μ(Year)	2,028.00	52	2,136.20	<0.0001
δ(Year) μ(Year+Reach)	2,040.58	52	2,148.77	<0.0001
δ(Year+Reach) μ(Year+Reach)	2,040.11	54	2,152.64	<0.0001
δ(Year+Reach) μ(Year)	2,055.00	50	2,158.87	<0.0001
δ(Year) μ(Year)	2,066.21	48	2,165.78	<0.0001
δ(Year*Mesohabitat) μ(Year*Mesohabitat)	1,918.12	144	2,240.29	<0.0001

Densities of RGSM
(Variation)

- Density trends, based on the four sampling occasions, were very similar to the overall long-term trend.

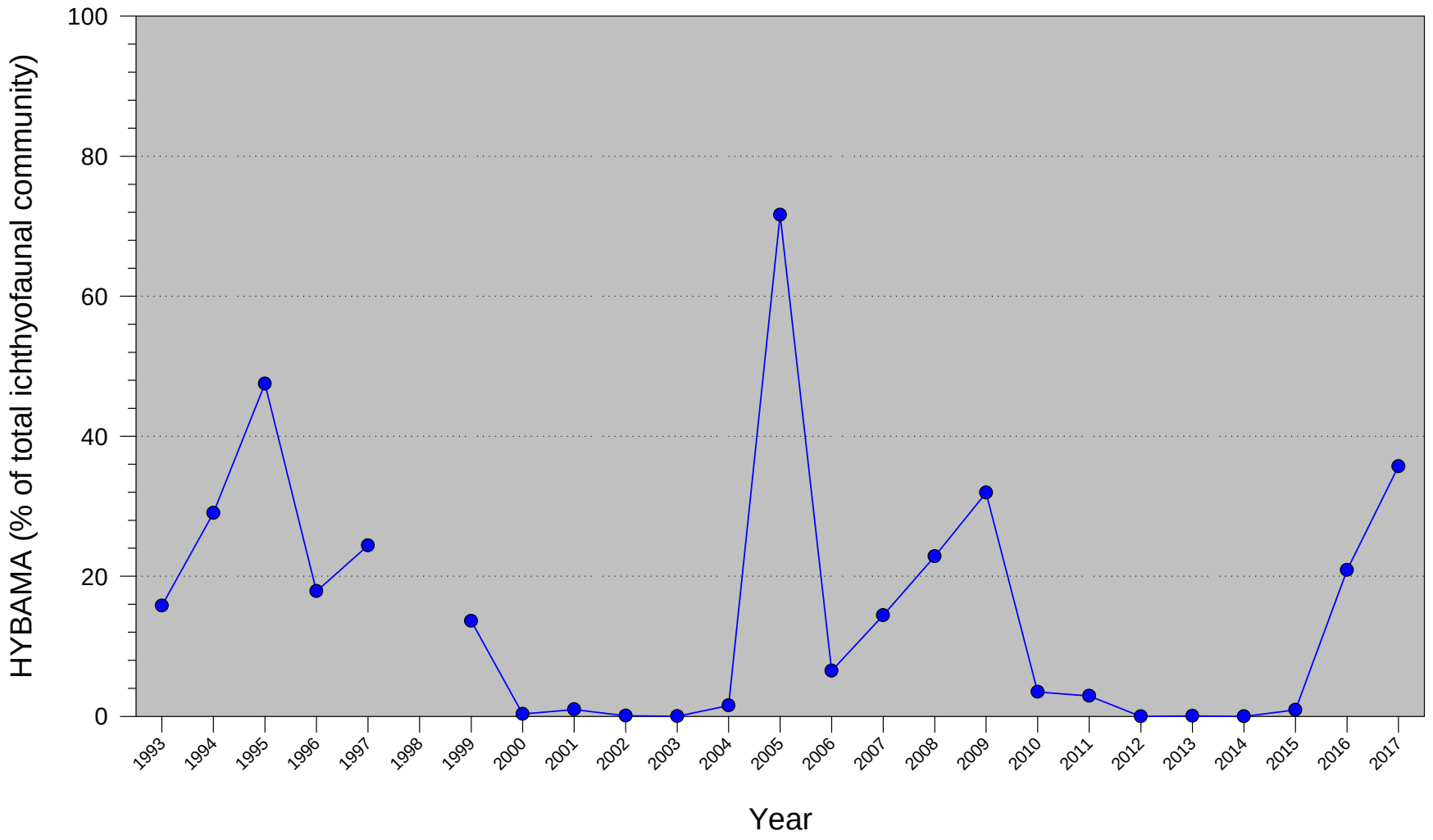
- Estimated densities were quite similar across the four sampling occasions.



Model Results for RGSM Variation (2005–2017)

Model	logLike	K	AIC_C	w_i
δ(Year*Reach) μ(Year*Reach)	1,433.87	117	1,697.82	>0.9999
δ(Year+Reach) μ(Year+Reach)	1,677.08	45	1,771.25	<0.0001
δ(Year+Reach) μ(Year)	1,737.48	41	1,822.93	<0.0001
δ(Year) μ(Year+Reach)	1,742.15	43	1,831.95	<0.0001
δ(Year) μ(Year+Occasion)	1,789.52	45	1,883.69	<0.0001
δ(Year) μ(Year)	1,803.02	39	1,884.14	<0.0001
δ(Year+Occasion) μ(Year+Occasion)	1,786.79	48	1,887.54	<0.0001
δ(Year+Occasion) μ(Year)	1,800.29	42	1,887.92	<0.0001
δ(Year*Occasion) μ(Year*Occasion)	1,690.54	156	2,058.01	<0.0001
δ(Year+Reach) μ(Reach)	2,177.21	21	2,220.12	<0.0001

Relative Abundance of RGSM (1993–2017)



Rank Abundance for Focal Species (2008–2017)

Species	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Red Shiner	1	1	1	1	1	1	1	1	1	2
Common Carp	7	10	9	10	6	9	8	9	7	6
Rio Grande Silvery Minnow	2	2	5	4	10	10	10	7	2	1
Fathead Minnow	5	6	6	7	5	4	6	6	8	8
Flathead Chub	4	5	2	3	3	6	3	3	4	5
Longnose Dace	8	9	7	8	8	3	5	5	6	7
River Carpsucker	9	7	8	5	7	8	7	8	9	10
White Sucker	10	8	10	9	9	7	9	10	10	9
Channel Catfish	6	4	4	6	4	5	4	4	5	3
Western Mosquitofish	3	3	3	2	2	2	2	2	3	4

Coefficient of concordance (W = 0.66) indicated consistency in species' ranks (1993–2017; $P < 0.001$).

Site Occupancy Results (2005–2017)

Site Occupancy Rates

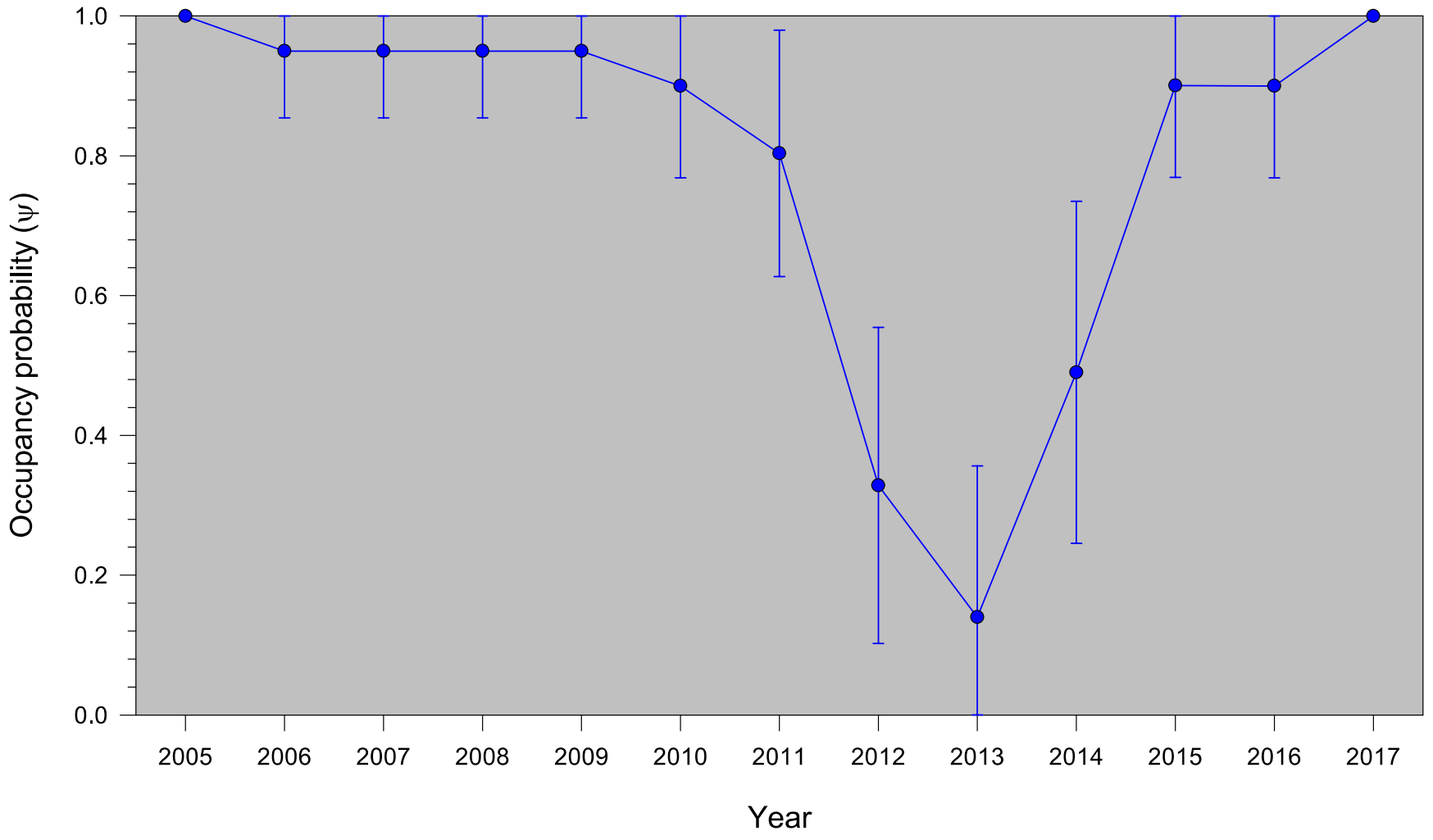
- “Few species are likely to be so evident that they will always be detected when present.” (MacKenzie et al. 2003)

- Site occupancy analyses were based on RGSM repeated-sampling data (presence vs. absence) collected in November (2005–2017).

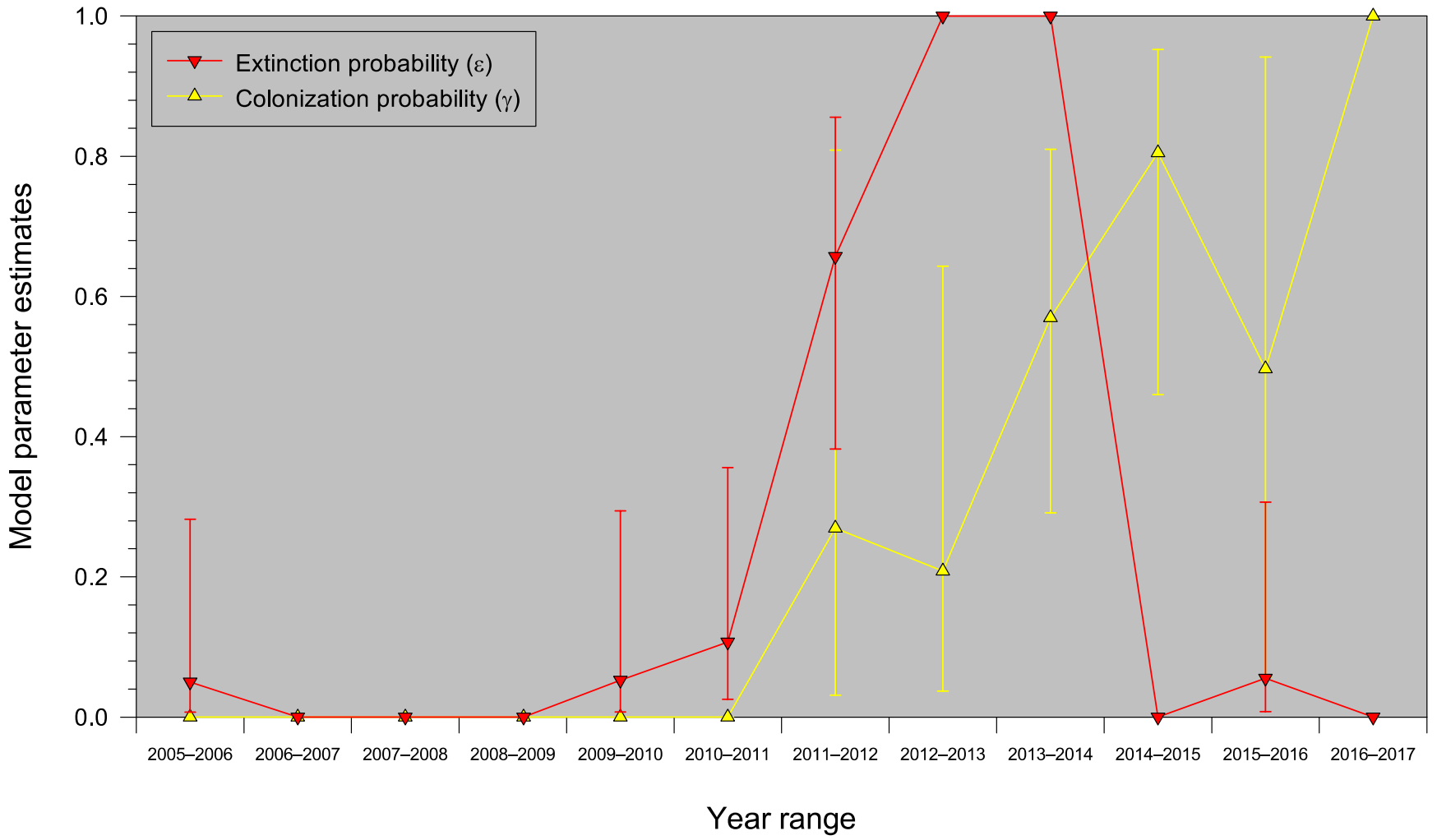
- Estimates of site occupancy rates were based on methods developed by MacKenzie et al. (2002, 2003, 2006), and Program MARK (White and Burnham, 1999) was used to compute all parameter estimates.

- Modeled parameter estimates included probability of detection (*p*), probability of occupancy (ψ), probability of extinction (ε), and probability of colonization (γ).

Occupancy Probabilities (All Ages)



Extinction & Colonization Probabilities (All Ages)



Summary

- While the estimated densities of RGSM were notably lower from 2012–2014 as compared with 2004–2011, their densities increased substantially from 2015 to 2017.

- Prolonged high flows during spring were most predictive of increased density, whereas prolonged low flows during summer were most predictive of decreased occurrence.

- Mesohabitat-specific and sampling-occasion density trends both closely mirrored the long-term RGSM density trend.

- Site occupancy estimates showed that RGSM has, at times, been lost from > 85% of its occupied sites since 2005. However, RGSM occupancy, extinction, and colonization estimates have improved markedly since 2013.

Conclusions

- Ongoing efforts to restore dynamic river flows, reconnect fragmented reaches, and reestablish a functional floodplain should help to promote resilient and self-sustaining populations of Rio Grande Silvery Minnow.

- Continued efforts to provide reasonable spring spawning and summer survival conditions will be essential for securing a self-sustaining wild population of this imperiled species in the Middle Rio Grande.

- The reestablishment of resilient populations of this species at other locations within its historical range in the Rio Grande Basin would help to further ensure its long-term persistence in the wild.

- Continued study of the key factors that control this complex aquatic ecosystem will be essential for developing and implementing successful strategies for the long-term recovery of Rio Grande

Acknowledgements

- **Field, Data, & Laboratory:** Adam Barkalow, Howard Brandenburg, Stephani Clark-Barkalow, Martinique Chavez, Michael Farrington, Austin Fitzgerald, Jennifer Kennedy, Curtis Peralta, Rosalee Reese, and Aaron Wedemeyer (ASIR & Museum of SW Biology [Fishes], UNM)

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- **Report Review:** U.S. Army Corps of Engineers, USBR, and U.S. Fish and Wildlife Service (USFWS)

- **Fish Sampling & Collection Permits:** Handling and collection of Rio Grande Silvery Minnow was authorized by the USFWS (Permit TE001623-4). The N.M. Department of Game and Fish authorized our handling and collection of all other native and nonnative fishes (Permit 1896).