

**NERRS Science Collaborative Progress Report**  
**Period: 09/01/12 through 02/28/13**

**Project Title:** *Legacy effects of land-use change and nitrogen source shifts on a benchmark system: Building capacity for collaborative research leadership at the Grand Bay Reserve*

**Principal Investigator(s):**

Ruth H. Carmichael, Ph.D., Dauphin Island Sea Lab, Dauphin Island, AL

**Project start date:** 09/15/10

**Report compiled by:** R. H. Carmichael (PI)

**Contributing team members and their role in the project:**

***Co-Is & Integration Lead***

Name (Co-I): CAPT William Burkhardt, III (microbial analyses)

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Name (Co-I, Reserve Representative): David Ruple (reserve interests, networking with end users)

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Name (Integration Lead): William Walton (coordination, communication with end users)

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***End-user Participants (formal, in proposal)***

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Name: H. Edwin Jackson (shell midden access, data consultation and application)  
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Name: Barbara Holley Reid, J.D. (community and working waterfront interests)  
\*Mrs. Reid passed away in early 2011.

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**A. Progress overview:** State the overall goal of your project, and briefly summarize in one or two paragraphs, what you planned to accomplish during this period and your progress on tasks for this reporting period. This overview will be made public for all reports, including confidential submissions.

***Research goal***

To measure land-use related N source and pathogen changes through time and define the resulting effects on ecosystem and human health in Grand Bay, AL by combining data from land-use models, sediment cores, modern sediment and water samples, ancient shell middens, living native and transplanted bivalves, and environmental attributes that cover time periods from up to 3000 years before present to 2020 for three subwatersheds and their receiving waters.

***Planned activities and anticipated accomplishments***

For this term (Y3: Q1 & Q2), we planned to refine landuse maps and projections; finish dating sediment cores & midden shells; continue processing native bivalve samples and estuarine attribute (YSI, water and sediment) sampling; analyze stable isotope and microbial data for water, sediments, and oysters; continue sampling relevant wastewater sources and continue sampling discharge; continue measuring oyster growth (cohorts and direct measurement); regularly update our Facebook page and discussion board; communicate with stakeholders; continue training students, technicians, and summer interns on technical methods; create metadata; and have a Working Group meeting.

We have begun or accomplished all of these tasks, except final dating of midden shells. We continued our second year of oyster transplants (an addition to the original plan of work), including collecting samples biweekly or monthly for oyster growth, stable isotope ratios in tissues and shell, water column chlorophyll, stable isotope ratios in SPM, dissolved nutrients, and YSI continuous water quality monitoring, and monthly sampling of fecal coliforms, *E. coli*, *Clostridium perfringens*, and male-specific coliphage. All of this effort was done in response to Working Group and Stakeholder participant feedback, above and beyond the original scope of work.

We continued our year-round effort to sample potential source material: wastewater influent and effluent sampling monthly from 3 local wastewater treatment plants (Pascagoula, Moss Point, and Bayou la Batre). WTP influent/effluent were also sampled for fecal indicator microbes and stable isotopes.

Hurricane Isaac (early September 2012) changed our plans slightly. To protect our oysters and gear, we made the decision to remove oysters from the field and hold them in a walk-in refrigerator until the storm passed. The result was that 80% of the oysters survived, but oysters from one site (Cumbest) all died after being returned to the field. We also expect to see a stress response in the oyster tissue isotopic signatures, and disruption of shell growth patterns during this time period, which will affect our analyses of these data (but should be traceable to the storm event, providing a useful temporal biomarker).

## **B. Working with Intended Users:**

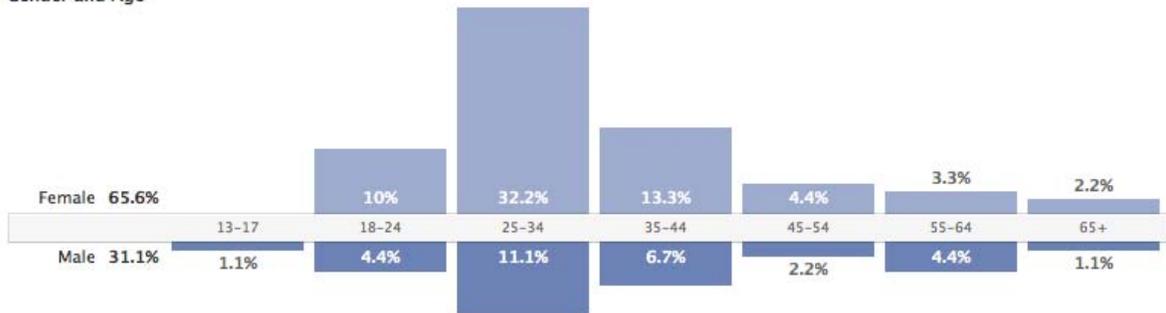
- Describe the progress on tasks related to the integration of intended users into the project for this reporting period.
- What did you learn? Have there been any unanticipated challenges or opportunities?
- Who has been involved?
- Has interaction with intended users brought about any changes to your methods for integration of intended users, the intended users involved, or your project objectives?
- How do you anticipate working with intended users in the next six months?

1. We continue our collaboration with end user Dr. Ed Jackson to date midden shell samples and collect data that complements his existing data set.
2. Integration Lead, Walton and graduate student Beth Condon (and PI Carmichael, to a lesser degree) maintained the project Facebook Page: <http://www.facebook.com/pages/Grand-Bay-National-Estuarine-Research-Reserve-Science-Collaborative/153046948084497> (open to the public)

Current 'likes' count of 98 (up 32% from the last report), with more typically than 200 viewers and 10 responders per week. Posts include research updates and images, particularly by graduate student Condon. This venue has proven useful to update participants and recognize and show appreciation for their efforts. In particular, the 'Reach' (defined as the number of unique individuals who have actually seen any content related to the Facebook Page) was substantial (Fig. 1).

**Who You Reached (Demographics and Location)**

**Gender and Age?**



**Countries?**

- 85 United States of America
- 1 Portugal
- 1 Kenya
- 1 Canada
- 1 Germany
- 1 United Kingdom

**Cities?**

- 18 Mobile, AL
- 5 Dauphin Island, AL
- 3 Birmingham, AL
- 3 Daphne, AL
- 2 Richmond, VA
- 2 Seattle, WA
- 2 Grand Bay, AL

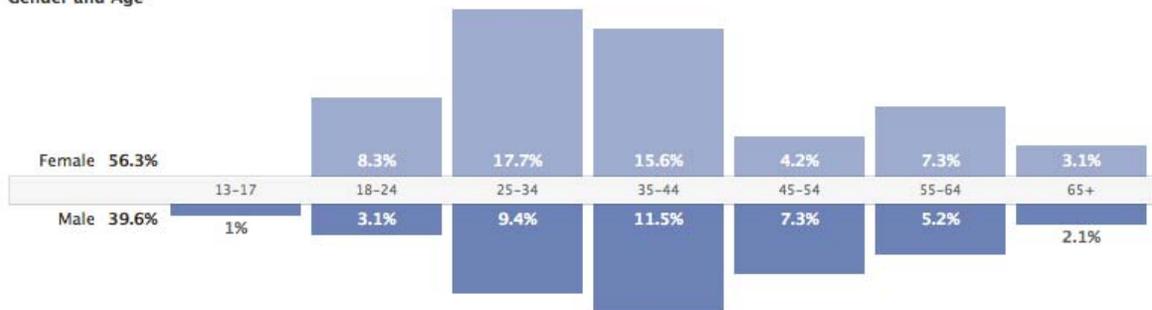
**Languages?**

- 85 English (US)
- 3 English (UK)
- 1 French (Canada)
- 1 Portuguese (Brazil)

**People Who Like Your Page (Demographics and Location)**

[See Likes](#)

**Gender and Age?**



**Countries?**

- 92 United States of America
- 1 Germany
- 1 Morocco
- 1 India

**Cities?**

- 20 Mobile, AL
- 6 Ocean Springs, MS
- 4 Dauphin Island, AL
- 4 Grand Bay, AL
- 3 Birmingham, AL
- 3 Theodore, AL
- 2 Manahawkin, NJ

**Languages?**

- 93 English (US)
- 2 English (UK)
- 1 French (France)

**Fig. 1.** ‘Reach’ (numbers of individual viewers) from 28 January 2013 to 24 February 2013 (top) and ‘Likes’ (number of individual viewers who opted to add our page to their daily newsfeed) from 01 December 2012 to 24 February 2013, demographics for the Grand Bay National Estuarine Research Reserve Science Collaborative Facebook Page.

3. Graduate student Condon led a tour of the Grand Bay shell middens, discussed project objectives and ecology with two local members of the interested public, 11/7/12.

- a. Tour participants sent thank-you notes expressing how much they learned about the ecology of the region, the beauty of the Grand Bay Reserve, and about the science of using stable isotopes and other indicators.
  - b. A tour participant expressed interest in her local chapter of the League of Women Voters having project scientists come to speak on their annual topic, “Water”.
  - c. A Carmichael Lab intern, Jessica Lajoie, who assisted with the tour is now considering pursuing work in science education.
4. Graduate student Condon hosted a boat tour of the Bayou la Batre wastewater treatment plant (WTP) outfalls 11/28/12: Condon, Marlin Johnson (Bayou la Batre Utility Authority Director), DISL PI Ruth Carmichael and FDA PI Kevin Calci attended. The group discussed the new WTP facility, location of new outfall, future dye studies and ecological impact studies, along with the potential utility of results from the current project
    - a. We will continue to interact closely with Mr. Johnson as Bayou la Batre proceeds with plans to move their wastewater effluent pipe further offshore, and conduct preliminary samples before effluent pumping to this location begins.
    - b. Current sampling of wastewater treatment plant effluent as the new plant has come online will help the Bayou la Batre Utility Authority demonstrate the efficacy of their new plant at reducing fecal indicator microbes and possibly nutrients.
    - c. Project will help Utility Authority work with FDA to plan dye studies to evaluate new plant effluent effects on local shellfish beds.
  5. Graduate student Condon and PI Carmichael met with Fred Andrus (University of Alabama Geology Department) to discuss processing and analysis of organic and inorganic (currently not part of the proposed study) stable isotope ratios in ancient shell and how archaeologists would use this information to determine season of capture, for which there is little information on the Gulf Coast. We established a collaboration with Andrus’s lab to sample oyster shells for  $\delta^{18}\text{O}$  (this effort will be a no cost addition to original plan of work due to the intellectual collaboration with Andrus)
    - a. This cross-discipline collaboration will help us learn geochemistry techniques and benefit geologists by including shellfish ecology in their work.
    - b. Archaeologists are very interested in season-of-capture information to track how native peoples migrated and used historic sites in this region (this aspect complements and builds on our original collaboration with MS Department of Archives and History, Dr. Ed Jackson, and Capt. K. Wilkinson).
    - c.  $\delta^{18}\text{O}$  values will allow more sophisticated aging techniques and more accurate comparison of growth rates in ancient vs. modern oysters, and may allow comparison of temperature variation between ancient and modern periods (which may also affect oyster growth).
    - d. Andrus run samples for free (minimal cost involved to process shells), which will leverage the current funding to include more information.
    - e. Andrus will serve on Condon’s graduate committee.

**C. Progress on project objectives for this reporting period:**

- Describe progress on tasks related to project objectives for this reporting period.

- What data did you collect?
- Has your progress in this period brought about any changes to your methods, the integration of intended users, the intended users involved or the project objectives?
- Have there been any unanticipated challenges, opportunities, or lessons learned?

### ***Stakeholder participation***

In addition to the stakeholder involvement described above, we continued our communication with the expanded stakeholder group defined in the last four quarters. We continue to have some difficulty getting involvement with MS water quality department of the DMR due to their other obligations. At the most recent Working Group meeting we devised a plan to set up separate smaller meetings with members of this and other core groups before the next larger stakeholder meeting. We plan to continue working to include each group as well as new contacts from the Jackson County and Bayou la Batre Utility Authorities in our end user meetings planned for the next quarter. This period we also processed samples (Microbial, nutrient, and stable isotope ratios) that indicate water quality problems in Bayou Chicot are concerning (higher than other water bodies), and spatial data suggest these problems possibly involve overflowing manholes or combined sewer overflows. We plan to incorporate managers from the City of Pascagoula as endusers in the coming months so that we can make them aware of our results.

### ***Field sampling, lab work and data analyses***

*Sediment cores*— Sediment core stable isotopes were analyzed, but we had some difficulty extracting enough N for reliable  $\delta^{15}\text{N}$  signatures from old and very inorganic sediments. As a result,  $\sim 2/3$  of the core sections now have accurate stable isotope values, but we will re-run  $\sim 30$  samples to obtain final values.

Based on sediment core data, we discovered that the tributaries we sampled in Bayou Cumbest, Bayou Heron, and Bangs Lake underwent a major shift in  $\delta^{13}\text{C}$  between 10 and 40 cm downcore, with sediments at all sites becoming more enriched nearer the surface. Open water sites Bayou la Batre and Point aux Chenes Bay did not undergo a similarly dramatic a shift. At Bayou Cumbest and Bangs Lake, shifts in  $\delta^{13}\text{C}$  corresponded to the 1960s-1970s (Fig. 2). The  $\delta^{13}\text{C}$  shift in Bayou Heron occurred earlier (late 1800s – early 1900s). In contrast to carbon values,  $\delta^{15}\text{N}$  values in sediments from different sites diverged near the surface with tributaries Bayou Cumbest, Bayou Heron, and Bangs Lake becoming more enriched in recent years. Sediments in Bayou la Batre also became much more enriched towards the surface. These shifts in  $\delta^{15}\text{N}$  began in the 1960s, with Bayou la Batre sediments enriched as far back as the 1850s (Fig. 3). We have comparable data for microbial values down core and in surface sediments.

*Oyster transplants*—We continued our second year of oyster transplants, starting in June 2012, Hurricane Isaac, however, required us to remove oysters from the field and hold them in a walk-in refrigerator until the storm passed. 80% of the oysters survived, but oysters from Bayou Cumbest died within two weeks after being returned to the field. We expect to see a stress response in the oyster tissue isotopic signatures and disruption of shell growth patterns during this time period, which will affect our analyses of these data, but provide a temporally explicit biomarker to corroborate growth measurements another environmental data. In the laboratory, we completed processing 2011 transplant oysters for growth and stable isotopes, dissolved nutrient samples, SPM stable isotope samples, chlorophyll *a*, and began 2012 dissolved nutrient and SPM stable isotope samples for 2012 transplant.

*Environmental & microbial data*—We continued our year-round environmental monitoring and microbial sampling associated with oyster transplant sites (as described in previous reports). This period we also continued our efforts to sample potential organic matter and contaminant source material to water and sediments, including wastewater influent and effluent (sampling monthly from 3 local wastewater treatment plants; Pascagoula, Moss Point, and Bayou la Batre) and stormwater. Samples were analyzed for fecal indicator microbes and stable isotope ratios.

We have also been working in tandem with Grand Bay NERR staff (Kim Cressman, SWMP coordinator) to evaluate extremely high phosphate concentrations measured in Bangs Lake and Point aux Chenes Bay after Hurricane Isaac (early September 2012). Our data helped supplement and confirm the Grand Bay SWMP data, and Kim and GBNERR Director Dave Ruple used the data in a report to AL Department of Environmental Quality, regarding detection of a possible industrial phosphate spill.

*Midden shells*—We have measured, weighed, and catalogued all midden shells provided by Dr. Jackson (archaeologist, USM), and are sending some soon for carbon dating. The cataloging and aligning midden data with other watershed and water column data was due to great level of detail in midden sampling provided by working with Dr. Jackson. These additional efforts should provide more temporally precise data comparisons among midden sites, making the additional processing time well worth the effort.

### ***Technical training***

- Co-I Calci (FDA) and student Condon continued working on laboratory techniques for the microbiology component of the project at the FDA Gulf Coast Research Lab on Dauphin Island. They also discussed an alternative enrichment method for processing MSC to lower the level of sensitivity.
- PI Carmichael and Condon continued training on shell slicing and acidification techniques in the Carmichael lab for application to midden shells provided by Jackson (USM). In particular the fragile structure of shells and intercalation of biota and sediments has required new methods development and some specialized techniques.
- Condon incorporated a number of students into the project, by inviting them to assist with field and lab work. Many of these students expressed interest in marine science or biology as a career, and were able to learn techniques such as water quality sampling, oyster sampling, isotope filtering, and YSI data sonde calibration and data analysis. During summer 2012, PI Carmichael hosted interns, Jessica Lajoie, Kristin Marino, Pavel Dimens, Andrew Morin, and Ben Nagel, who worked closely with Condon, learning oyster transplant and growth measurement and stable isotope sample preparation techniques. Several other graduate and undergraduate students also assisted Condon and benefitted from learning field techniques and lab analyses.

### ***Land-use modeling***

Co-PIs from GCRL continued refining land cover land use (LCLU) mapping, with a focus on impervious areas within the GBNERR and the neighboring areas. Discussion at the Feb 2013 Working Group meeting revealed that aerial photographs as early as 1950 will be needed to increase the temporal domain and capture the period most relevant to shifts in biological data from the region. Land use predictions will be extended to 2020 by accounting for sub-pixel

information of impervious areas. A manuscript describing the methods and approach to analyzing the LCLU data is submitted.

- What are your plans for meeting project objectives for the next six months?
  1. We will continue processing data from transplanted oysters, shell middens, and native bivalves, and analyzing data for estuarine attributes at each site. We will continue stable isotope analyses on sediment, water, and oyster samples, measuring bivalve growth and survival on transplanted oysters and based on native collections and core captures. We will continue extracting organic material from ancient bivalve shells (1000-2000 years old) and analyzing stable isotopes of this material. We will begin training on the inorganic stable isotope analysis methods and begin compiling the LCLU dataset with the biological dataset, particularly for sediment core data.
  2. Additional priorities include: (1) sample potential N and fecal indicator sources under a variety of conditions, (2) continue oyster deployments for the coming months, (3) send midden samples for  $^{14}\text{C}$  dating.
  3. We will continue operation and maintenance of the Facebook page and Google discussion board, make at least one public or scientific presentation to share data from the project, as well as continue data analyses and student and technician training.
  4. We plan to hold several smaller stakeholder sub-meetings and one comprehensive stakeholder meeting during the next 6 months.
  5. We also plan to request a no-cost extension to allow us to complete tasks associated with the additional scope of work added in response to stakeholder/enduser inputs and extension of the transplant period for oysters.

**D. Benefit to NERRS and NOAA:** List any project-related products, accomplishments, or discoveries that may be of interest to scientists or managers working on similar issues, your peers in the NERRS, or to NOAA. These may include, but are not limited to, workshops, trainings, or webinars; expert speakers; new publications; and new partnerships or key findings related to collaboration or applied science.

1. Ongoing collaboration with Dr. Ed Jackson, USM.
2. Ongoing collaboration with the Grand Bay NERR and EPA project by Dr. J. Cebrian.
3. Presentations

Gong, C., and W. Wu, 2011. A hybrid remote sensing model for mapping the impervious surface of urban area adjacent to Grand Bay Reserve. Annual University Research Awards Day, Nov-2012, Hattiesburg, Mississippi. (Poster-Award winner, campus-wide, unsolicited)

Gong, C., and W. Wu, 2011. A hybrid remote sensing model for mapping the impervious surface of urban area adjacent to Grand Bay Reserve. Grand Bay NERR Research Symposium, Oct-2012, Moss Point, Mississippi. (Poster, regional, unsolicited.).

Darrow, E.S., R.H. Carmichael, K.R. Calci, W. Burkhardt “Sedimentary organic matter source shifts due to land use change in a northern Gulf of Mexico estuarine system” Poster presentation, Gulf Estuarine Research Federation biennial meeting, November 8-9, 2012, Dauphin Island, AL

Darrow, E.S., R.H. Carmichael, K.R. Calci, W. Burkhardt “Sedimentary organic matter source shifts due to land use change in a northern Gulf of Mexico estuarine system” Oral presentation, Association for the Society of Limnology and Oceanography annual meeting, February 17-22, 2013, New Orleans, LA

#### Publications

Gong, C., and W. Wu. Submitted. Effects of shadow, atmospheric correction and seasonal factors on the extraction of subpixel imperviousness using regression tree modeling. Submitted to Photogrammetric Engineering & Remote Sensing ; revision submitted Jan-2013.

#### Awards

Elizabeth S. Darrow (Condon) was awarded a Wetland Society Student Travel Grant of \$1200 to attend the Coastal and Estuarine Research Federation meeting in San Diego, CA, November 2013.

#### **E. Describe any activities, products, accomplishments, or obstacles not addressed in other sections of this report that you feel are important for the Science Collaborative to know.**

- Graduate student Condon is serving as DISL’s Graduate Student Organization Treasurer, 2012-2013
- Graduate student Condon participated in DISL’s Research Integrity Workshop, 10/5/12

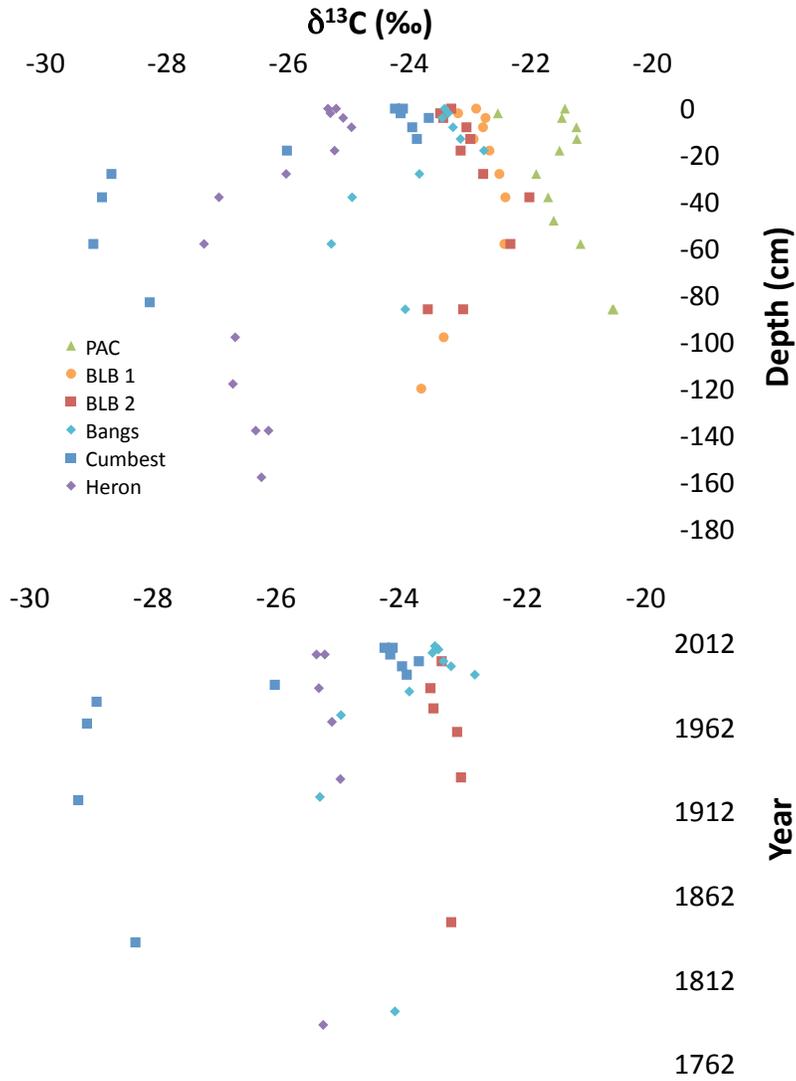


Fig. 2. Carbon stable isotope ratios in down-core sections (A) and through time (B) in sediment from 6 sites in Grand Bay, Mississippi. Dates were derived from  $^{210}\text{Pb}$  dating. PAC = Point aux Chenes, BLB (1, 2) = Bayou La Batre, Bangs = Bangs Lake, Cumbest = Bayou Cumbest, Heron = Bayou Heron.

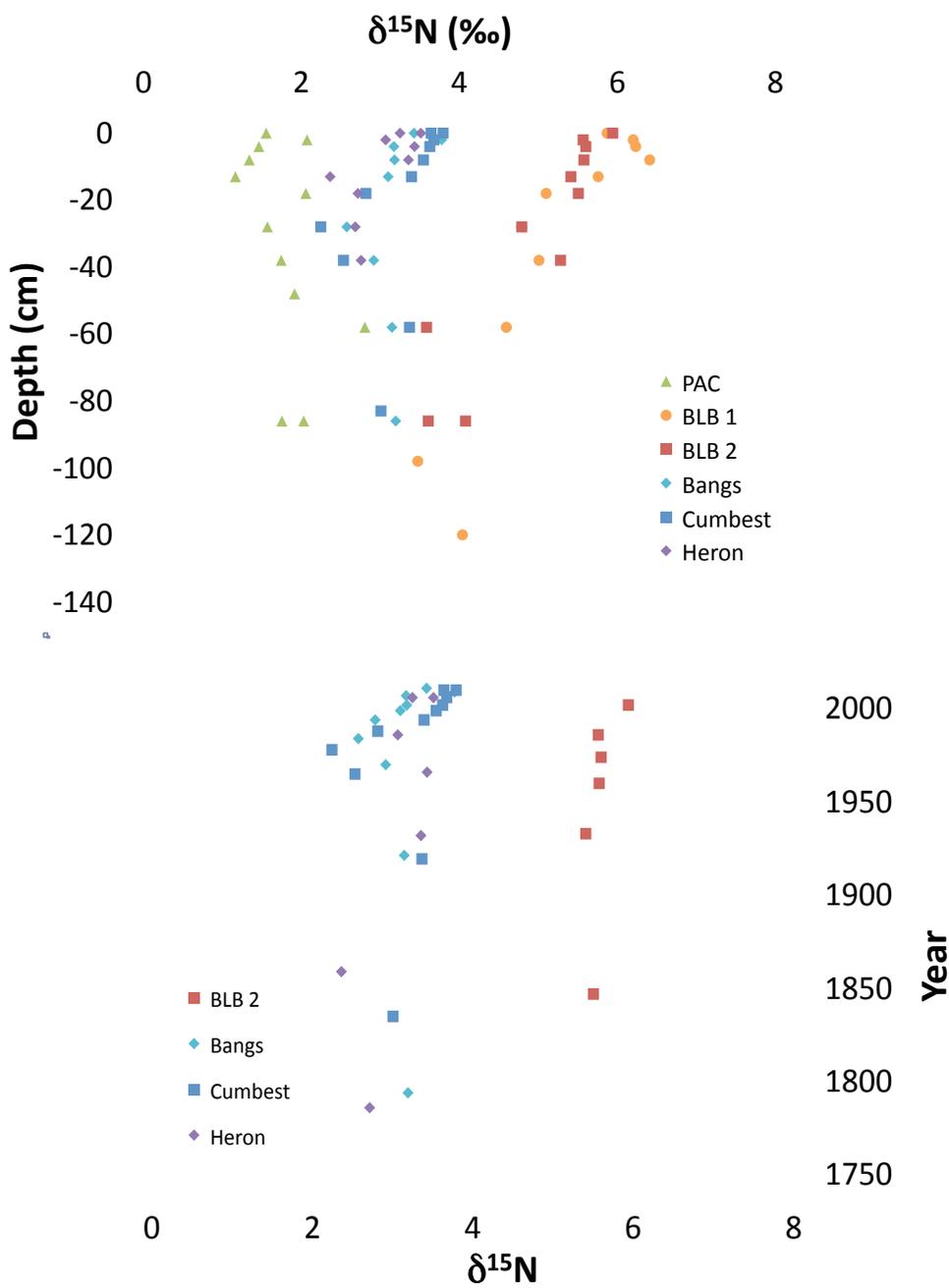


Fig. 3. Nitrogen stable isotope ratios in down-core sections (A) and through time (B) in sediment from 6 sites in Grand Bay, Mississippi. Dates were derived from  $^{210}\text{Pb}$  dating. PAC = Point aux Chenes, BLB (1, 2) = Bayou La Batre, Bangs = Bangs Lake, Cumbest = Bayou Cumbest, Heron = Bayou Heron.