Earthwatch 2017 Annual Field Report

INVESTIGATING ECOLOGICAL MISMATCHES AND OCEAN ACIDIFICATION IN ACADIA NATIONAL PARK

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Period covered by this report: June 2017-October 2017

Dear Earthwatch Citizen Scientists,

We are looking at a graph from the field season. I find myself drawn to one dot and muse about the work that went into that one, single dot. A crew of volunteers carried gear into the field—someone shared a bird sighting and someone shared a story about marathoning in her youth. Someone held a hand while crossing seaweed or held a branch for the person behind them. A number was recorded. Lunch was eaten, and maybe a snack or two was traded. A number was entered into a computer, and now that number—with all the others—is helping to tell a story and answer a research question. And those dots—those abstractions of a lot of hard work, those answers to questions, are thanks to you. Thank you for joining us in 2017 in Acadia National Park as we work to understand how a changing climate will change species interactions and the face of a national treasure.

We counted, and then estimated.
Measured carapace widths and seaweed length.
Recorded species, number, and time it took for snails to flip over.

In all it was 2600 phenology plot surveys, 1040 of insect traps collected, 3717 individual seaweeds identified, and 524 crabs measured!

The dots on the page may help to answer questions but they only tell part of the story. The story is about humans trying to understand the world around them. And a chapter in that book is about how a small group of thoughtful, committed people is digging into research to make the world a better place for themselves and all other living creatures. You are in that chapter. It's written with your sweat and whacking at flies. It's written with your laughter and perplexity at Latin names. It's written with your awe of this earth we're entrusted with. Thank you for sharing your hard work and dedication with us. Please share your stories with others—you all and the stories are part of the awe.

With gratitude,

Hannah Webber and Abe Miller-Rushing

SUMMARY

Species interactions

The species interactions project ran successfully this year; with help from Earthwatch we counted fruit and measured arthropod biomass weekly in 10 subplots in each of 10 plots across 2 sites in the Schoodic Peninsula. Our counts started on July 26 and lasted until October 17. For the first time, we also measured dry fruit biomass, which allows us to account for species differences in fruit size.

Ocean acidification

This year we continued to sample quadrats (n=4) at 13 rocky-intertidal sites along the coast of the Schoodic Peninsula (1300 sample points) to monitor for changes due to ocean acidification and warming (OAW). This was the fourth year that we sampled these quadrats. We also sampled, for the second year, three transects at 10 sites.

Island resurvey

For the forest research, we revisited 14 forest plots and 4 photopoint transects initially sampled in 1992 and 1993 on two islands off the Schoodic Peninsula. The Earthwatch volunteers navigated to the sites, relocated plots, and identified and measured vegetation from the smallest plants on the forest floor to the largest trees in each plot. We also established and sampled six additional forest plots within the Schoodic District of Acadia National Park that are part of a larger research project examining forest responses to changing conditions. Earthwatch volunteers identified and measured 911 trees across 20 forest plots.

GOALS, OBJECTIVES, AND RESULTS

Goal 1: Investigate the interactions among birds, insect, and fruits and quantify the extent of spatial and temporal mismatch.

We counted fruits weekly for eight of the most common fall fruiting shrubs on the Peninsula. Of our two sites, Alder was more diverse and productive than Sundew (Fig. 1). At Sundew, only Mountain Holly and Huckleberry produced fruit in quantity (Fig. 1). The two species had peak biomass production on almost the same date at both sites (Fig. 2).

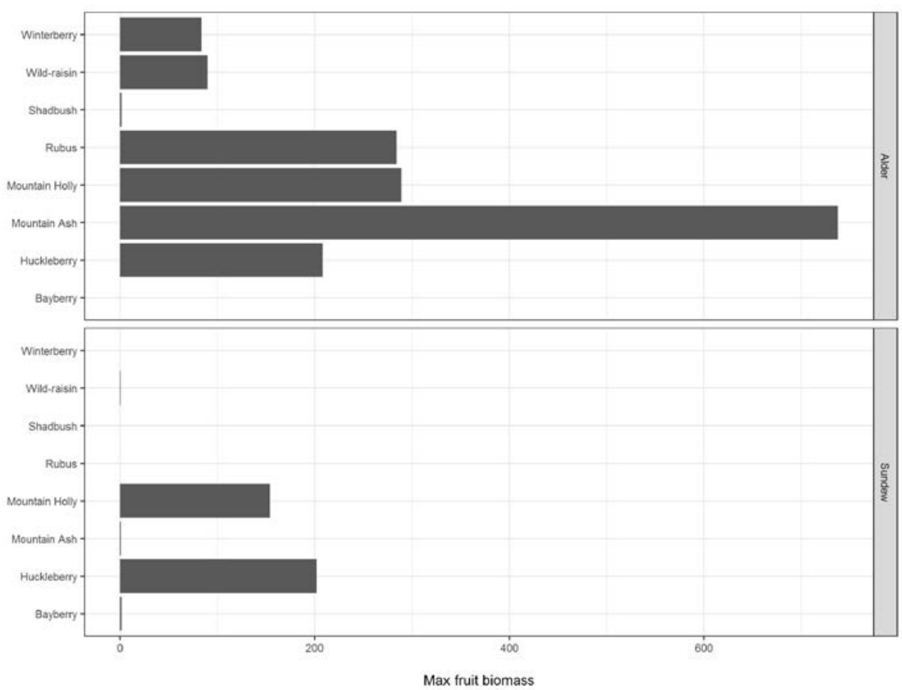


Figure 1: The maximum total fruit biomass measured during the 2017 field season (July 20 – Oct 18).

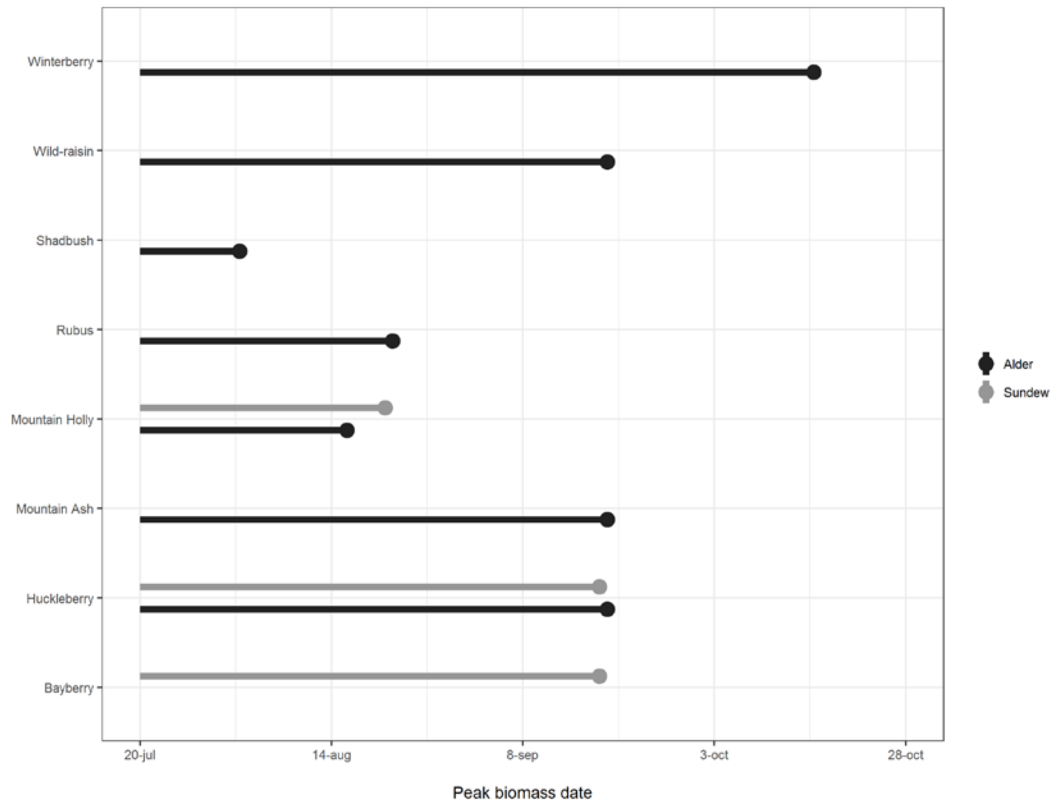


Figure 2: The date at which biomass was highest in 2017.

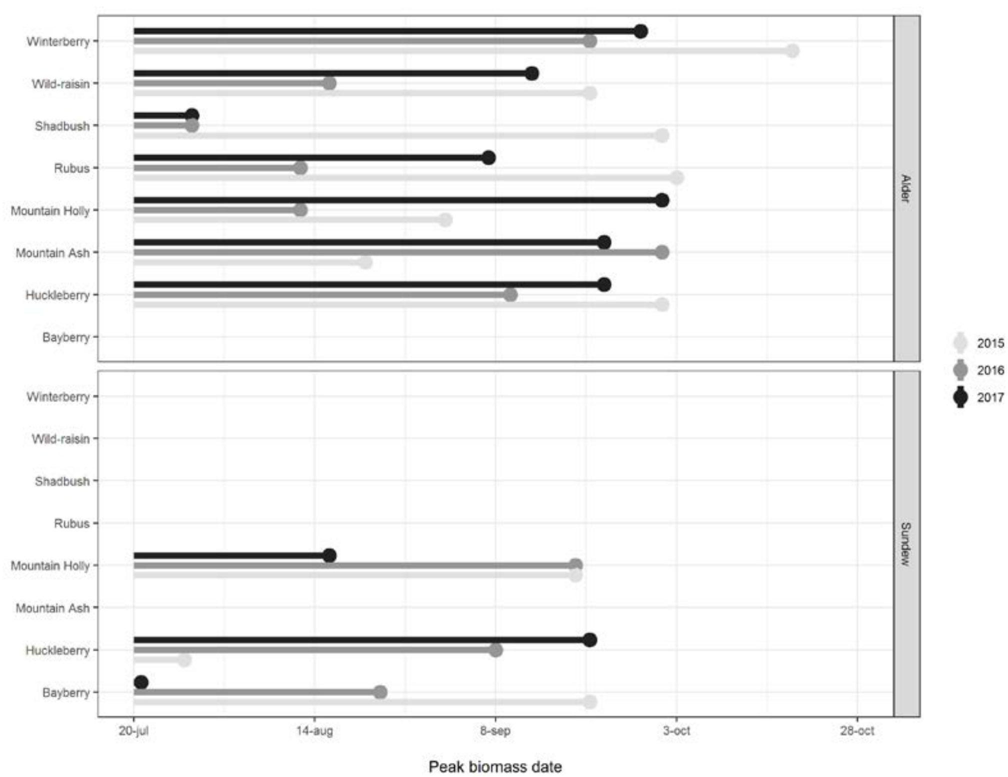


Figure 3: The date at which biomass peaked for each fruiting species in 2015, 2016, and 2017.

We can combine our data from 2017 with the previous two years to reveal trends in phenology over time. We found considerable variation among years in the date at which fruit production peaked (Fig. 3). For example, Huckleberry peaked in production 56 days later in 2017 than in 2015. Meanwhile at Alder, Mountain Holly peaked in production 50 days later in 2017 than 2016. In general, at Alder, production peaked earliest in 2016 and latest in 2015, with Mountain Ash being a noticeable exception (Figs. 3, 4, 5). At Sundew, Mountain Holly peaked earliest in 2017 and latest in 2015 while Huckleberry had the opposite pattern (Figs. 3, 4, 5).

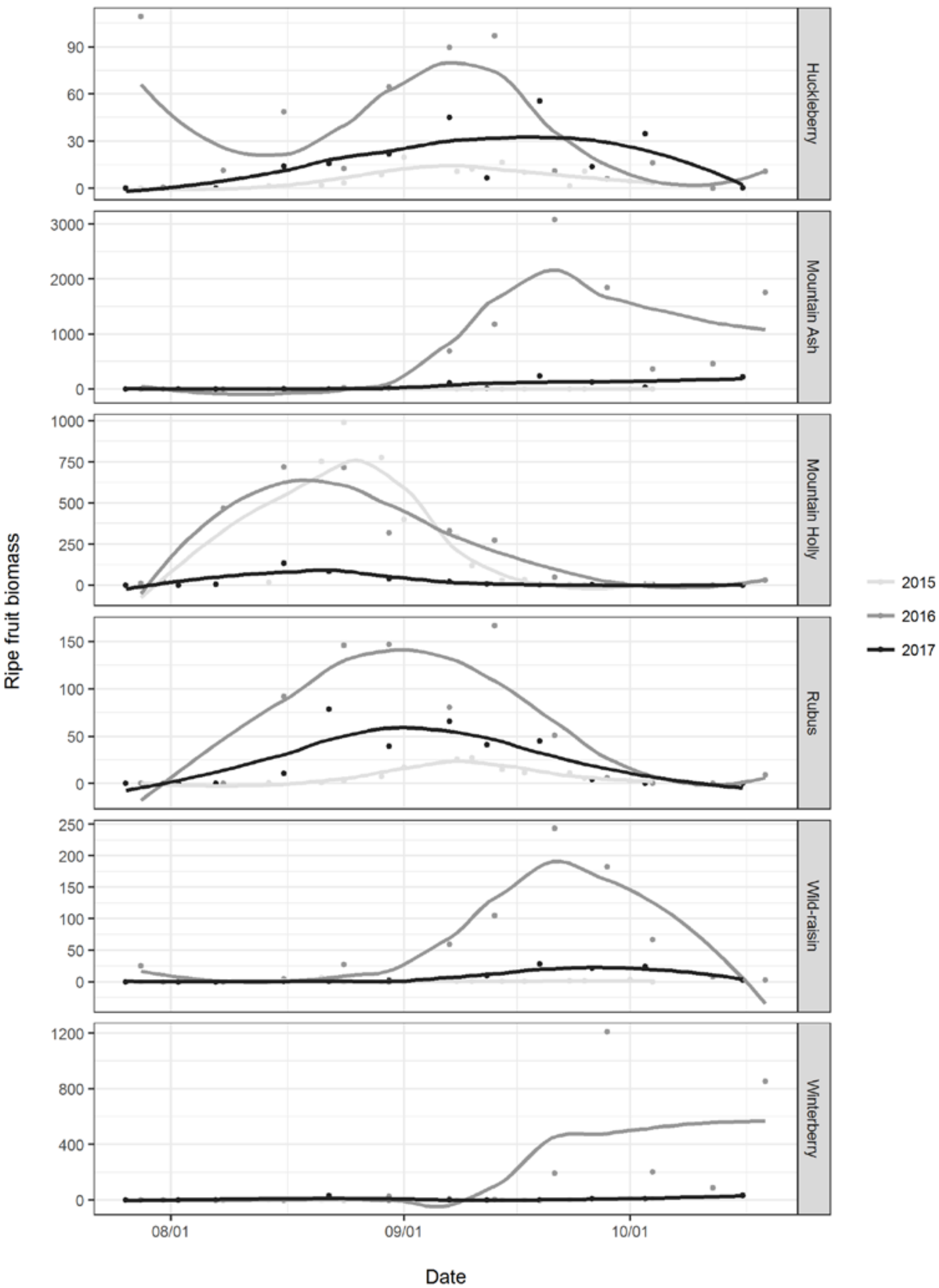


Figure 4: Fruiting phenology for the common species observed at the Alder site in 2015, 2016, and 2017. The values are daily total biomass measured across 10- 1m x 2 m subplots nested within 10- 12m x 24m plots. The curves are best-fit smooths calculated by the package “ggplot2”in R.

Total fruit biomass tended to be greater in 2016 than the other years in both sites (Figs. 4, 5). However, at Alder, biomass was lowest in 2015 (Fig. 4) while at Sundew biomass was lowest in 2017 (Fig. 5).

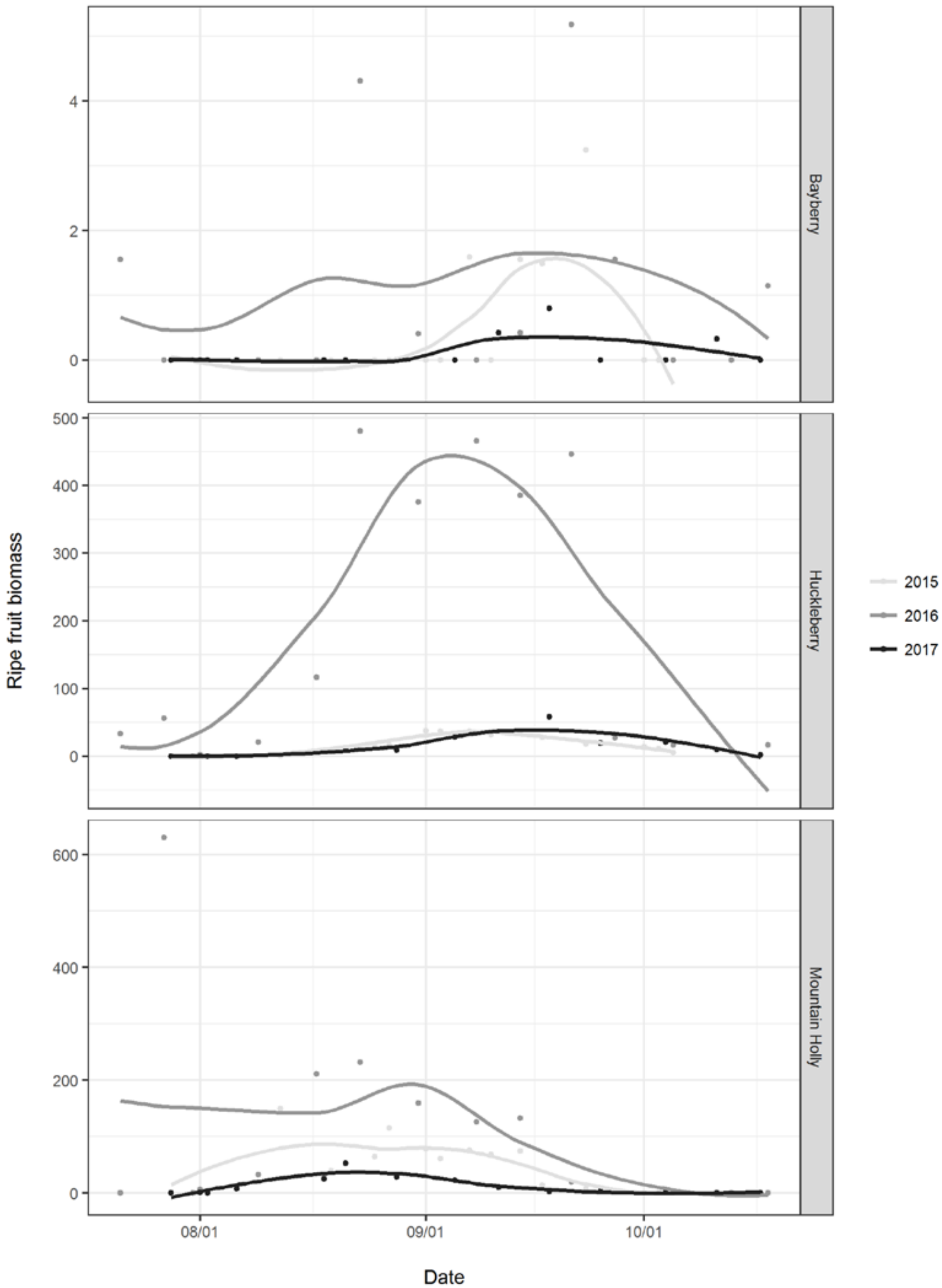


Figure 5: Fruiting phenology for the common species observed at the Sundew site in 2015, 2016, and 2017. The values are daily total biomass measured across 10- 1m x 2 m subplots nested within 10- 12m x 24m plots. The curves are best-fit smooths calculated by the package "ggplot2"in R.

Arthropod phenology also changed over the years, with peak biomass occurring increasingly earlier in the season in Alder but increasingly later in the season in Sundew (Fig. 6). (We do not analyze 2015 data because sampling started late that year). The change in peak date ranged from 41 days earlier in Alder in 2017 than 2016 and 77 days later in Sundew in 2017 than 2016.

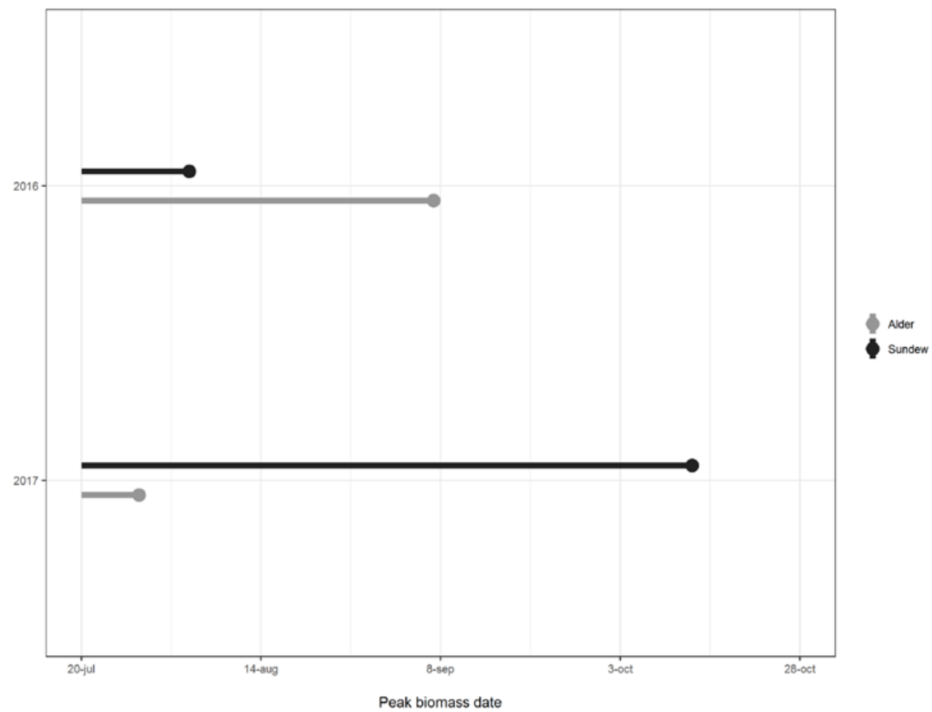
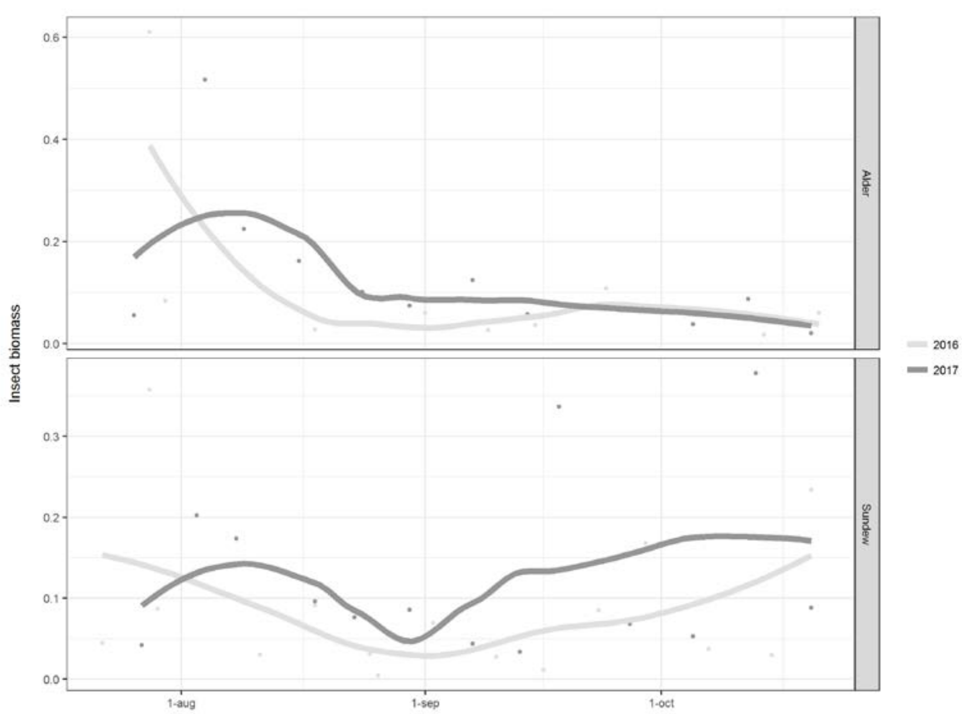


Figure 6: The date at which arthropod biomass peaked in 2016 and 2017.



Overall, arthropod biomass was higher in 2017 than 2016 (Fig. 7). A noticeable difference between sites is that at Alder biomass declines steadily through the autumn while at Sundew biomass dips in early September and then increases through the rest of the season. The pattern was evident in both years (Fig. 7).

Figure 7: Arthropod phenology at the Alder and Sundew sites in 2016 and 2017. The values are daily total biomass measured across 4 sampling cups nested within 10- 12m x 24m plots. The curves are best-fit smooths calculated by the package “ggplot2”in R.

Goal 2: Investigate the effects of ocean acidification on intertidal organisms and communities.

The field sampling we are doing would be sufficient to determine if community experience changes over time, however, it is likely to take consistent monitoring over several years to determine these changes because they are predicted to be small at the beginning. We are monitoring ocean pH and temperatures so we will be able to determine if changes in structure are correlated to changes in ocean chemistry.

We also continued with our lab studies on the behavioral effects of OAW. Volunteers also collected population data on green crabs (an important, invasive intertidal predator)—in all we collected 524 green crabs (slightly less than 2016's 573 crabs). Overall there was no difference in carapace widths between the two sites, the density of crabs was slightly higher overall on the western side of Schoodic peninsula, and the populations at the two sites varied week to week, the population on the western side appears to stay at higher densities for a longer period of time (Figure 8).

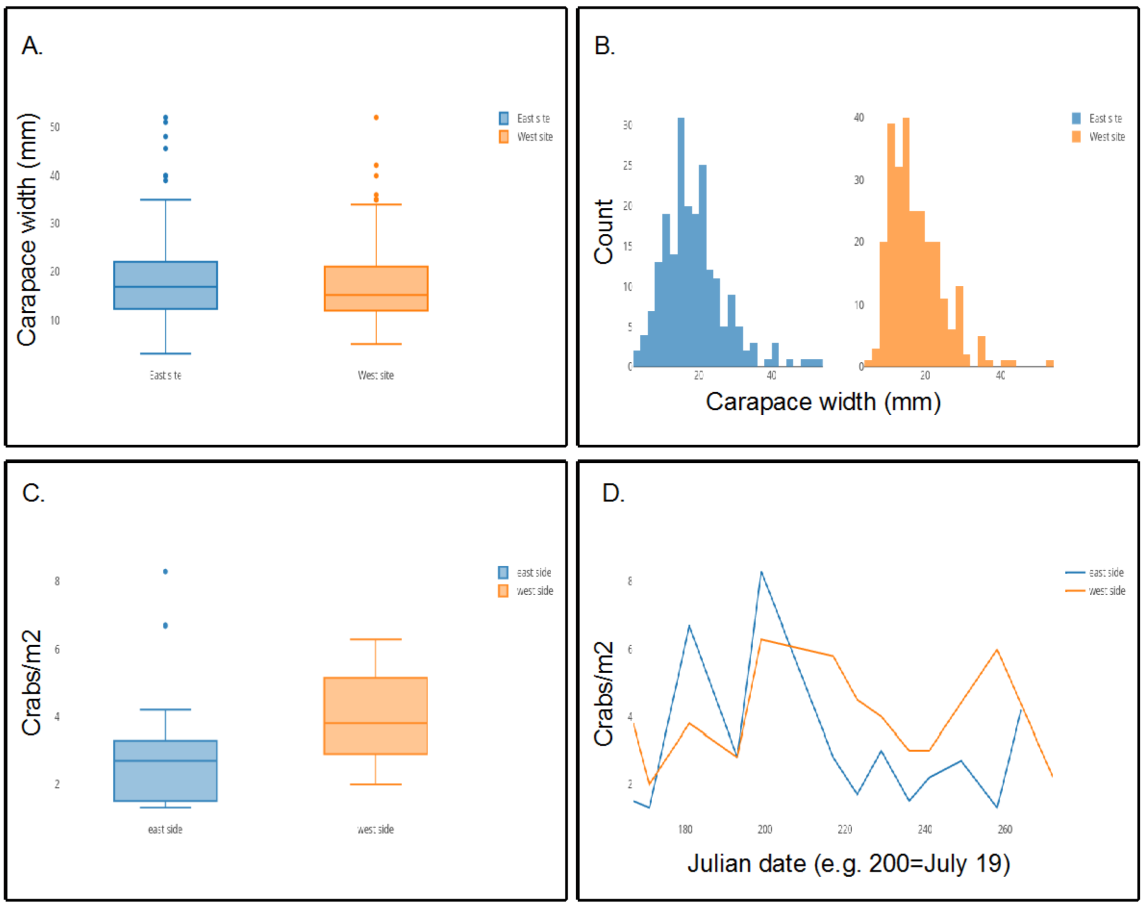


Figure 8: Schoodic peninsula green crab (Carcinus maenas) surveys, June16-September 29, 2017. Samples collected from two sites, one on the eastern side of the peninsula, one on the west. Size of crabs, and size distribution are the same on both sides of the peninsula (panels A. and B.).

Goal 3: Improve science literacy, environmental stewardship, and civic engagement among participants.

Continuing the work we began in late 2015 this year we introduced participants on all teams to three common citizen science applications—iNaturalist (collecting and sharing *biodiversity discoveries),* eBird *(collecting data on birds),* and Nature's Notebook (collecting *phenology data*), as well as a citizen science program—Caterpillars Count. We used iNaturalist to run an intertidal bioblitz with one Earthwatch team—identifying 49 intertidal species (compared to the 27 species previously listed). We used Nature's Notebook to collect phenology data on a walk on Schoodic peninsula (to compare to the species interactions plots). Earthwatch volunteers contributed to the 11201 (total) phenology observations.

By training participants to use citizen science tools, and a program (Caterpillars Count) meant to be used anywhere, we hope to encourage stewardship in backyards and local (to the participants) activism anywhere. Participants on five of the 2017 teams applied these new app skills to a data collection effort at different land trusts in the Acadia National Park region as part of the Shell Stakeholder Engagement Fund work.

Goal 4: Determine the response of the composition and structure of the park's mainland and island forests and associated understory communities

Earthwatch helped to initiate the resampling of historical forest plots on islands of Acadia National Park. We sampled plots on two islands with Earthwatch volunteers and opportunistically sampled forest plots on two other islands during the summer months. Thus, we have completed resampling on four of the eight total islands with historical forest plots. It is a high priority to sample the rest of the islands and synthesize the results of this work. (Figure 9: Photopoint example)

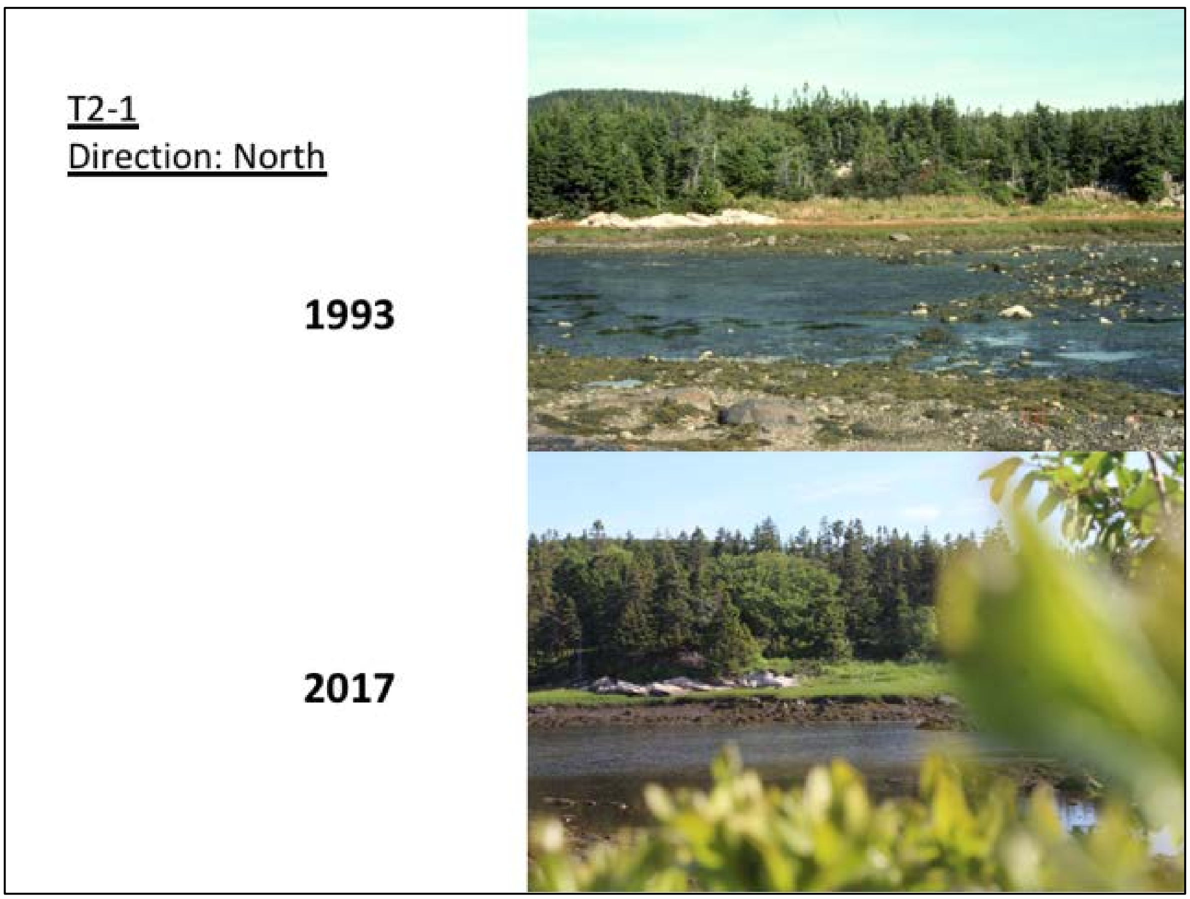


Figure 9: Little Mose Island photopoint 1993 and 2017

PROJECT IMPACTS

1. Increasing Scientific Knowledge

a) Total citizen science research hours

Earthwatch volunteers contributed an average of 10 hours/day for each field day for an estimated total of 5,600 hours of fieldwork.

b) Peer-reviewed publications: None

c) Non-peer reviewed publications *(Technical reports, white papers, articles, sponsored or personal blogs)*: None

d) **Books and book chapters:** Cigliano, J.A. and H.L. Ballard (2017) Citizen science for coastal and marine conservation. Routledge

e) Presentations (*Indicate if this was an invited paper, panel presentation, keynote speech, plenary address, or other):*

INVITED SEMINARS (Feldman)
Bird migration. Campus de Ciencias Sociales Económico-Administrativas y Humanidades de la Universidad Autónoma de Yucatán, Mérida, Yucatán, October 6, 2017.

The voyage south: the unpredictable future of bird migration. Universidad Nacional Autónoma de México, Unidad Académica Yucatán, Sisal, Yucatán, September 22, 2017.

POSTER (Cigliano)
Cigliano, J.A. 2017. Studying the effects of ocean acidification and warming (OAW) on rocky intertidal communities with high-school citizen scientists. *2nd Citizen Science Association Conference*

2. Mentoring

a) Graduate students *(List graduate students doing thesis work on the project):*

Student Name	Graduate Degree	Project Title	Anticipated Year of Completion
Hannah Webber	PhD	Rockweed food web ecology[1]	2022

[1] Webber is a first year PhD student. Her proposal has not been filed with the University.

b) Community outreach *(Provide details on how you have supported the development of environmental leaders in the community in which you work):*

Name of school, organization, or group	Participants local or non-local	Details on contributions/ activities
Petit Manan Wildlife Refuge	Local	Species interaction data collection on non-Acadia National Park conserved land to expand the geographic range of our species interaction work.
Downeast Lakes Land Trust	Local	
Maine Audubon	Local	
Blue Hill Heritage Trust	Local	
Island Heritage Trust	Local	
Acadia Senior College	Local	
Acadia Teaching Fellows	Local	Taught teacher fellows to use iNaturalist and Nature's Notebook in support of integration into classrooms.

3. Partnerships

Partner	Support Type(s)[1]	Years of Association (e.g. 2006-present)
Acadia National Park	Logistics, permits, collaboration	2014-present
Schoodic Institute	Logistics, permits, technical support, collaboration	2014-present
University of Maine	Logistics, permits, technical support	2015-present

1. Support type options: funding, data, logistics, permits, technical support, collaboration, academic support, cultural support, other (define)

4. Contributions to management plans or policies

Plan/Policy Name	Type[2]	Level of Impact[3]	New or Existing?	Primary goal of plan/policy[4]	Stage of plan/policy[5]	Description of Contribution
Acadia National Park resource management plan	Management plan	Local	New	Natural and cultural resource conservation	Adopted	Science from project was incorporated into models and into the plan
Acadia National Park intertidal planning	Management planning process	Local	New	Natural and cultural resource conservation	In process	Earthwatch project data and results are being considered as a part of the planning process
Frenchman Bay Partners Rockweed Conservation Action Plan	Management Plan	Local	New	Natural resource conservation	In progress	Working with local partners on plan for ecological and economically sustainable rockweed use.

2. Type options: agenda, convention, development plan, management plan, policy, or other (define)
3. Level of impact options: local, regional, national, international
4. Primary goal options: cultural conservation, land conservation, species conservation, natural resource conservation, other
5. Stage of plan/policy options: proposed, in progress, adopted, other (define)

5. Conserving natural and sociocultural capital

a) Conservation of taxa

i. List any focal study species that you did not list in your most recent proposal

Species	Common name	IUCN Red List category	Local/regional conservation status	Local/regional conservation status source
Carcinus maenas	Green crab		Invasive	

ii. In the past year, has your project helped conserve or restore populations of species of conservation significance? If so, please describe below.

Species	IUCN Red List category	Local/regional conservation status	Local/regional conservation status source	Description of contribution	Resulting effect[6]

6. Resulting effect options: decreased competition, improved habitat for species, range increased, population increase, improved population structure, increased breeding success, maintained/enhanced genetic diversity, other

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b) Conservation of ecosystems

In the past year, has your project helped conserve or restore habitats? If so, please describe below.

Habitat type	Habitat significance[7]	Description of contribution	Resulting effect[8]
Intertidal	Key area for many species, recreation, economically valuable species	Assessing impacts of warming and acidification on species and interactions	Informs planning and management actions
Boreal forest	Critical for migratory birds (millions pass through each year), and many warblers and other species breed in this habitat	Understanding mismatches between birds and food sources; identifies vulnerable species	Informs planning and restoration (e.g., planting of species that fruit at particular times)

7. Habitat significance options: nursery, breeding ground, feeding site, corridor, migration path, refuge, winter range, summer range, spring range, fall range or other (define)

8. Resulting effect options: extent maintained, condition achieved, restored, expanded, improved connectivity or resilience

c) Ecosystem services *(Indicate which ecosystem service categories you are directly studying in your Earthwatch research and provide further details in the box below):*

☐Food and water (yes) ☐Spiritual, recreational, and cultural benefits (yes)

Details:

Most of the work is related to identifying biodiversity (especially birds and intertidal species) vulnerable to changes in climate and ocean pH. Birds and intertidal species are among the top attractions for visitors to Acadia National Park. 3.5 million visitors came to Acadia in 2017, more than 2.5 times as many people as the population of Maine (1.3 million). Acadia National Park tourism accounts for a huge amount of the state's economy, and a reduction in the quality of visitor experience could affect the economy. Relatedly, the quality of intertidal ecosystems affects shellfish and other fisheries, which are major components of the regional and state economy.

RESEARCH PLAN UPDATES

Report any changes in your research since your last proposal/annual report. For any 'yes' answers, provide details on the change in the 'Details' box.

1) Have you added a new research site or has your research site location changed? ☐**Yes**
2) Has the protected area status of your research site changed? ☐**No**
3) Has the conservation status of a species you study changed? ☐**No**
4) Have there been any changes in project scientists or field crew? ☐**Yes**

Details – provide more information for any 'yes' answers

We resurveyed two islands (originally surveyed in the early 1990's)—Pond Island and Little Moose Island—these sites were new to this project. We welcomed Nick Fisichelli to our crew as project Co-PI. Nick works on the island and mainland forest composition research. Marcella Heineke and Tara Miller joined our crew as seasonal technicians.

5) Provide details on any changes to your objectives, volunteer tasks, or methods, include reason for the change.

We added the following field tasks in support of the island re-survey: re-establishing photopoints, collecting data on tree size, species, health, identifying and cataloging social trails.

ACKNOWLEDGEMENTS

We thank Acadia National Park for their support of the work of Earthwatch volunteers. Acadia has provided logistics assistance, funding for field transportation, and help with permitting and regulations. We thank all of the employees at Schoodic Institute who made our field season run smoothly (especially when we needed last-minute changes to meals, room assignments, or when we needed help with field gear). We thank the local community for sharing their knowledge with us. We thank the Durfee Foundation for sending us wonderful, inquisitive volunteers. We thank Shell for sending us hardworking and happy volunteers who pushed us into really excellent conversations about conservation. We thank all of the volunteers who chose to spend their time working alongside us to help us understand what the changing climate is doing to the flora and fauna of Acadia National Park.