Utilizing citizen science to identify, map and monitor wild brook trout genetic structure in the Adirondack Park

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Jordan Ross, Mark Usyk, John Montefusco, Paul Miller, and “The Usual Suspects” and the Sagamore Institute of the Adirondacks

What is Citizen Science?

- AKA crowd science, crowd-sourced science, civic monitoring, volunteer monitoring, networked science, participatory monitoring/research
- Scientific research conducted, in whole or in part, by amateur or nonprofessional scientists
- A good idea with an image problem…

Photo Credit: Brian F. Powell

Prevalence of Citizen Science Data

PLOS ONE

RESEARCH ARTICLE

An Analysis of Citizen Science Based Research: Usage and Publication Patterns

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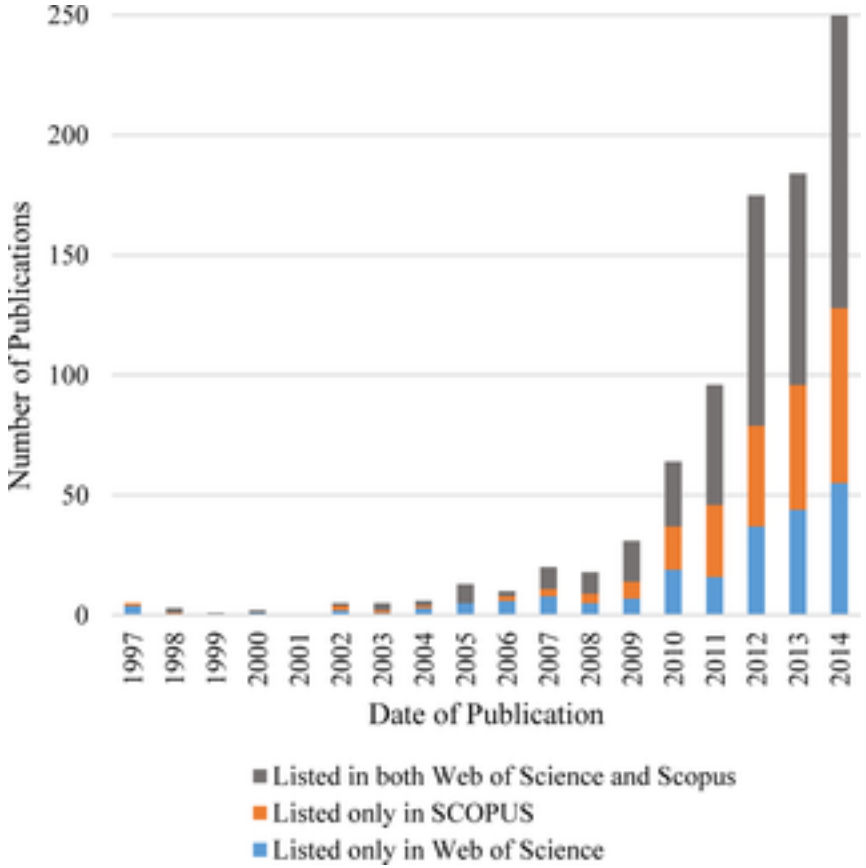
Dramatic growth between 1997 to 2014 in publications featuring citizen science…

Follet and Strezov, PLOS ONE (2015)



Value of Citizen Science Data

Volunteers contribute ~$2.5B annually to biodiversity research!!

Biological Conservation 181 (2015) 236–244

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Biological Conservation

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Global change and local solutions: Tapping the unrealized potential of citizen science for biodiversity research

E.J. Theobald [a,*,1], A.K. Ettinger [a,1,2], H.K. Burgess [b,3], L.B. DeBey [a,5], N.R. Schmidt [b,6], H.E. Froehlich [c,7], C. Wagner [c,8], J. HilleRisLambers [a,9], J. Tewksbury [a,4], M.A. Harsch [a,10], J.K. Parrish [c,11]

Scientific Value Often Underestimated

OPEN ACCESS Freely available online

PLOS ONE

The Invisible Prevalence of Citizen Science in Global Research: Migratory Birds and Climate Change

Caren B. Cooper[1]*, Jennifer Shirk[1], Benjamin Zuckerberg[2]

1 Cornell Lab of Ornithology, Ithaca, New York, United States of America, 2 University of Wisconsin, Madison, Wisconsin, United States of America

- Evaluated review of 10 claims of impacts of climate change on avian migration
- No reference to “citizen science” found in publications, although citizen science contributed to 24-77% of references
- Significance of citizen science to research greater than perceived

“Quality of data collected by volunteers, on a project-by-project basis, has generally been found as reliable as the data collected by professionals"

Proceedings of the 44th Hawaii International Conference on System Sciences - 2011

From Conservation to Crowdsourcing: A Typology of Citizen Science

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Action

Encourage participant intervention in local concerns, using scientific research as a tool to support civic agendas.

Virtual

Project activities are ICT-mediated with no physical elements whatsoever, differentiating them from the Investigation projects in which the physical places of volunteer participation was also important.

Conservation

Support stewardship and natural resource management goals, primarily in the area of ecology; engage citizens as a matter of practicality and outreach; like Action projects, strongly rooted in place

Education

Make education and outreach primary goals, all of which include relevant aspects of place. Focus on both informal and formal learning opportunities.

Investigation

Focused on scientific research goals requiring data collection from the physical environment; while education is not always an explicit goal, it is frequently a strongly valued but unstated purpose.

Great Camp Sagamore is a National Historic Site in the Adirondack Wilderness. The Sagamore Institute uses the power and beauty of its location and the quality of its programs to foster understanding, care, and respect for nature, people and their critical interdependence. Our success is measured in our ability to inspire in those who visit or stay, individual responsibility to nature and community.”

TROUT POWER

Enlisting the power of anglers to protect, restore and enhance heritage brook trout populations and their habitats across their native range, through citizen science, advocacy and stewardship.

Protocol for Collecting Fin Clips for DNA Analysis

The following is a guideline of how the Trout Power organization has collected fin clippings tissue samples from brook trout in New York Adirondack Mountains. The following has been created by Trout Power with consult from the NYS Museum in Albany, NY and specific consult from Spencer Bruce. The following is a guideline and protocol specifically for catch and release activity encompassing trout species.

Kit Contents**

A- Sharp scissors and/ or hand-held hole punch (1 of either. Cost $8/$2 respectively)
B- Serialized vials filled with 90% ethanol. (6 vials per team/angler. Vials cost approximately $20 per 100. Ethanol $10 per pint) Vials can be provided by Trout Power INC.
C- Disposable butane lighter for disinfection. (1 per kit.)
D- 1 Gallon Zip loc Bags (12 each, Cost $8 per 96)
E- Tweezers (1 each; Cost $7 each)
F- Map of assigned stream segment. Maps should be protected with lamination**
G- Permanent marker such as a Sharpie. (two per team, Cost $1.00 each)
H- Digital camera/smartphone (optional but highly recommended)
I- Handheld GPS Unit. (optional but highly recommended)

Sample Collection Procedures

Before Sampling – Getting Organized

1) Identify waters to be sampled and create maps of the area to delineate sections for individual teams to sample.
2) Get historical stocking records for the prior 10 years from NYSDEC and any possible private sources.
3) Prepare adequate number of vials for the planned sampling event. Vials must be in a material that accepts ether or grain alcohol and filled with 90% ethanol.
4) Serialize/number all vials for the sampling in permanent marker.
5) Assemble sampling kits and record vial serial numbers to be distributed to individual anglers/teams.
6) Assign streams/stream segments to be sampled to teams of two or three people considering the capabilities of individual anglers and challenges of each stream/segment.
7) Distribute Sampling Kits, brief teams/anglers on *Streamside* and *After Sampling* procedures, their assigned area and determine when they will return from the field,

Streamside - Sample Collection

1) Catch a fish.**
2) While fish is still on the line, in the water, fill an unused zip-loc bag with water to put fish in until ready to take sample. Leave the fish on the hook until sample is taken.
3) Verify that hole punch/scissors and tweezers are sanitized or sanitize them by burning them with butane lighter.
4) Cut/punch 1/4 " X 1/4" (tic-tac sized) sample from webby part of upper caudal/tail fin above the V of the tail
5) Using tweezers, secure the sample and place it in a serialized, unused vial and seal tightly. Place vial in a separate clean, unused zip-loc bag. Care must be given to not cross-contaminating samples; one sample per vial, one vial per bag.
6) Photograph fish if possible. This is optional
7) Revive and release the fish.
8) Record by GPS or on map, location where sample was collected, sample number and photo number.
9) Before continuing to fish/take further samples, sanitize tissue cutting/handling tools (scissors, hole punch, tweezers) with disposable lighter and organize sampling kit to expedite handling/taking your next sample. Stow used bags away from unused equipment.

The biggest risk in the entire process is cross contamination. You can never be too clean or too organized. Take special care and attention to keeping all your tools clean and disinfected after each use. It is also very important that each day supplies are left out to dry and are not allowed to rust or corrode.

After Sampling – Handling Samples and Equipment

1) At the end of the day, all samples, vials and sampling kits need to be collected and every sample vial needs to be accounted for. Every day all vials and tools need to be returned to the group leader for record keeping/security.
2) All sampling tools need to be re-cleaned before the next outing.
3) All samples need to be checked that they are in good order and are clearly marked
4) All samples need to be recorded on a master sheet noting location where they were taken e.g. latitude, longitude (or location relative to an identifiable fixed point), stream name, etc..
5) Empty vials need to be checked and verified as unused/uncontaminated.
6) Any vials that do not have enough fluid in them can be re-filled.
7) Sampling kits should be restocked.
8) Samples ready for testing can go into a refrigerator until analysis/testing. (samples can be left for a period of 24 hours at room temp in vials in alcohol.)

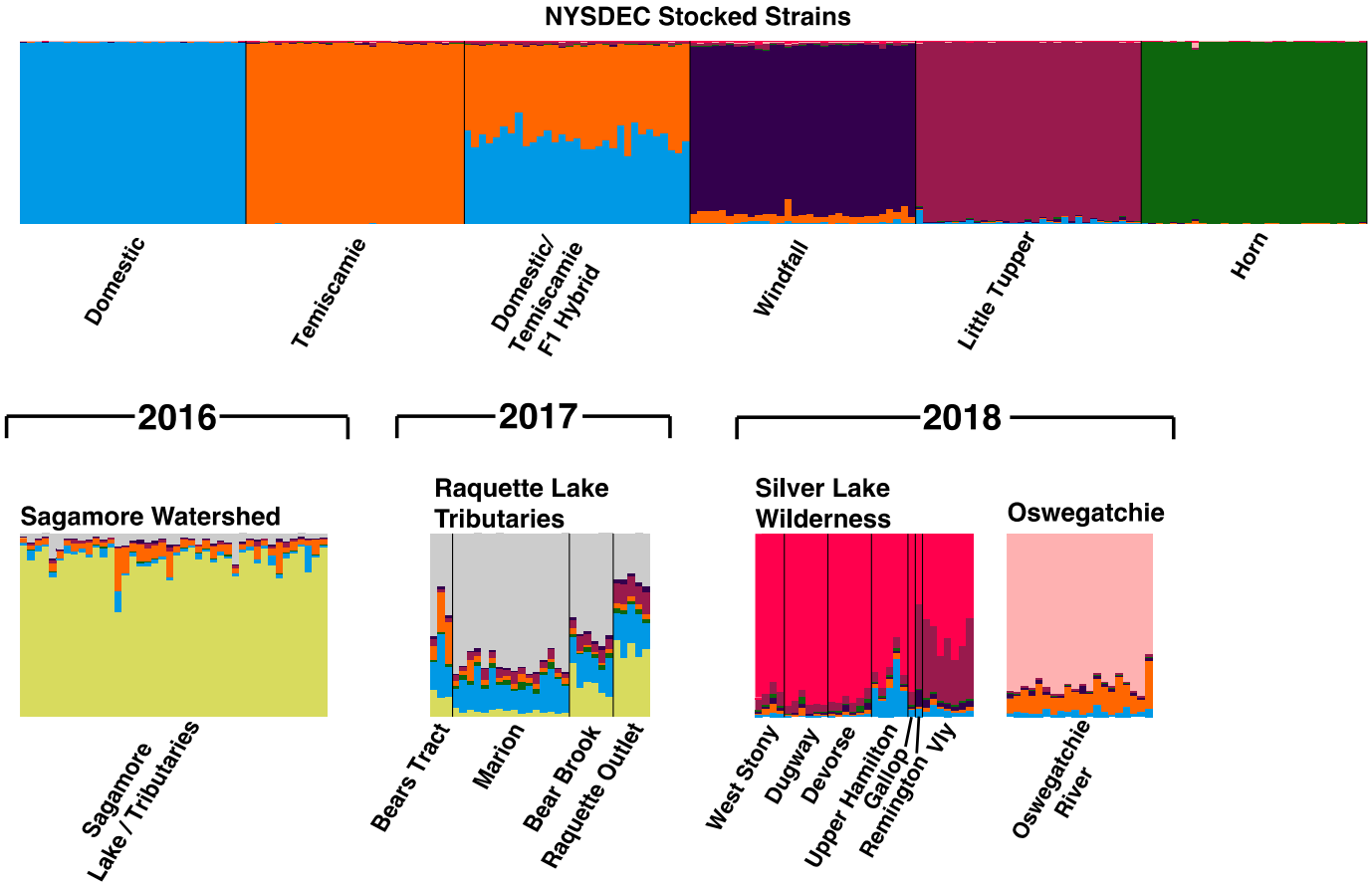
** Individual angler provides fishing gear, camera and a GPS if they have them.

Three Types of Brook Trout in New York

Native Brook Trout
(reproduce naturally in the wild, uninfluenced by stocking practices)

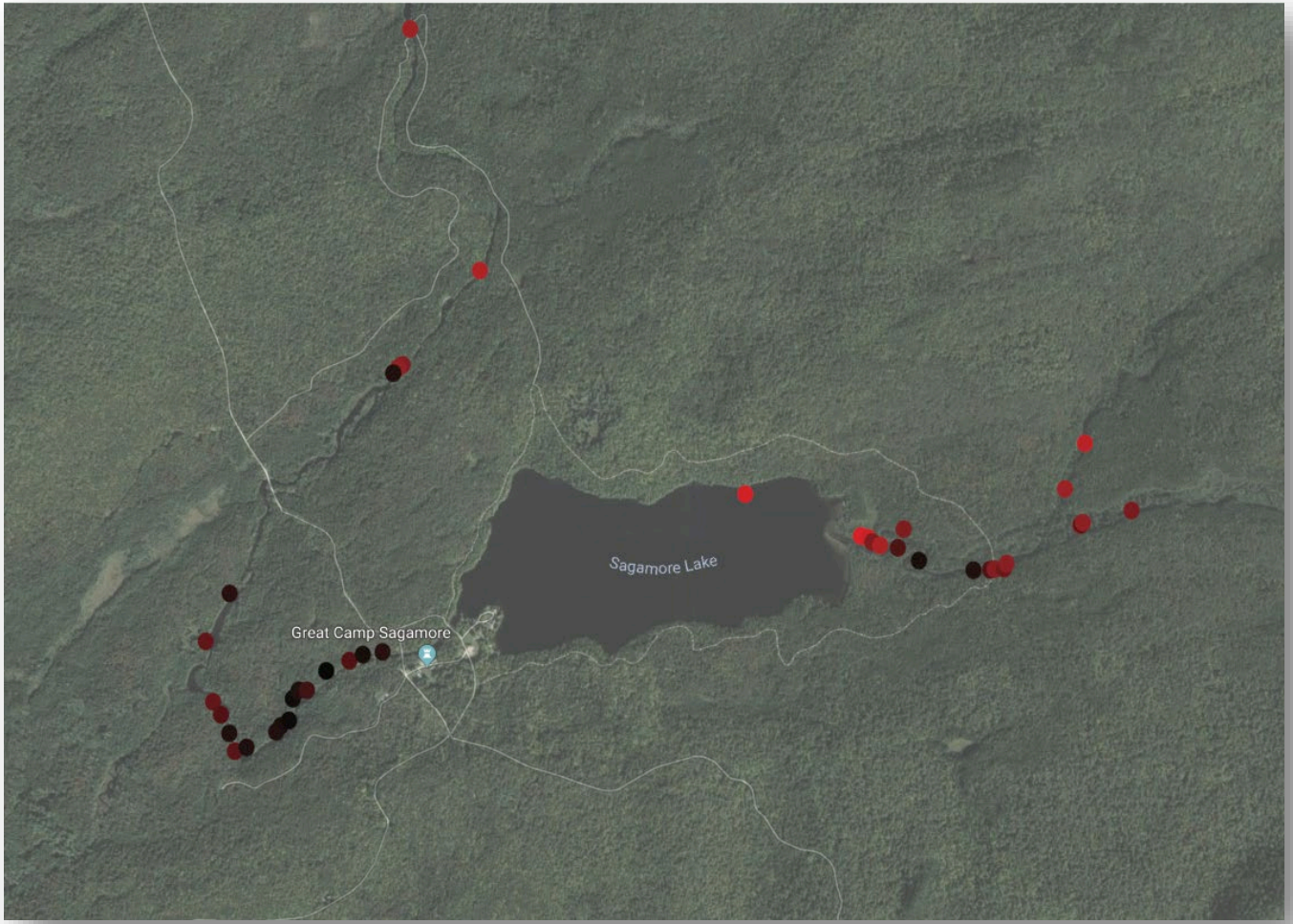
Stocked Brook Trout
(raised in a hatchery or brood pond)

Wild Brook Trout
(reproduce naturally in the wild, may be native, a hybrid, or offspring of stocked fish)



STRUCTURE bar plots: Each vertical line in the STRUCTURE plot represents an individual fish, and colors represent their inferred ancestry from 9 different populations.

Sagamore Watershed – 2016

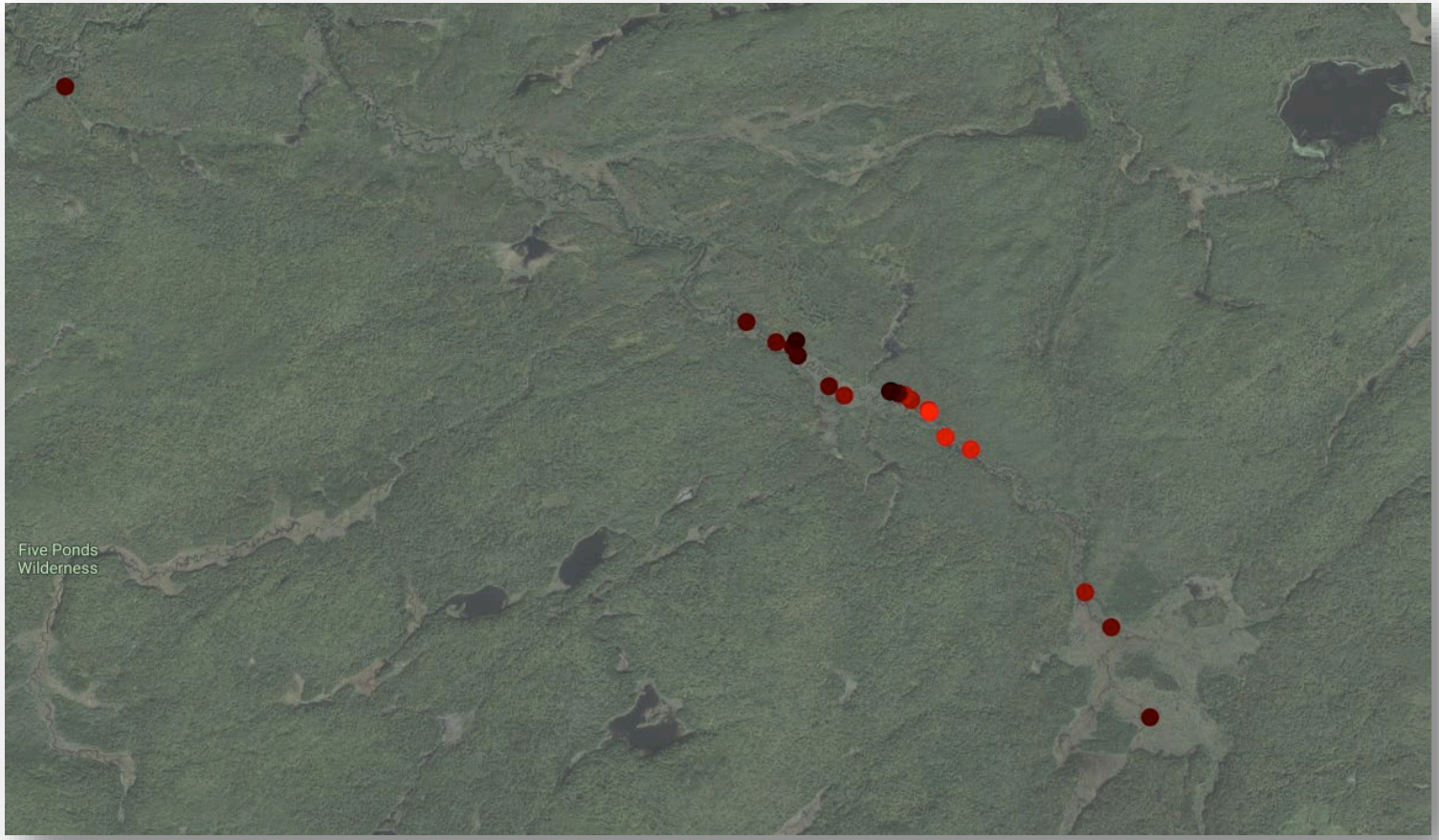


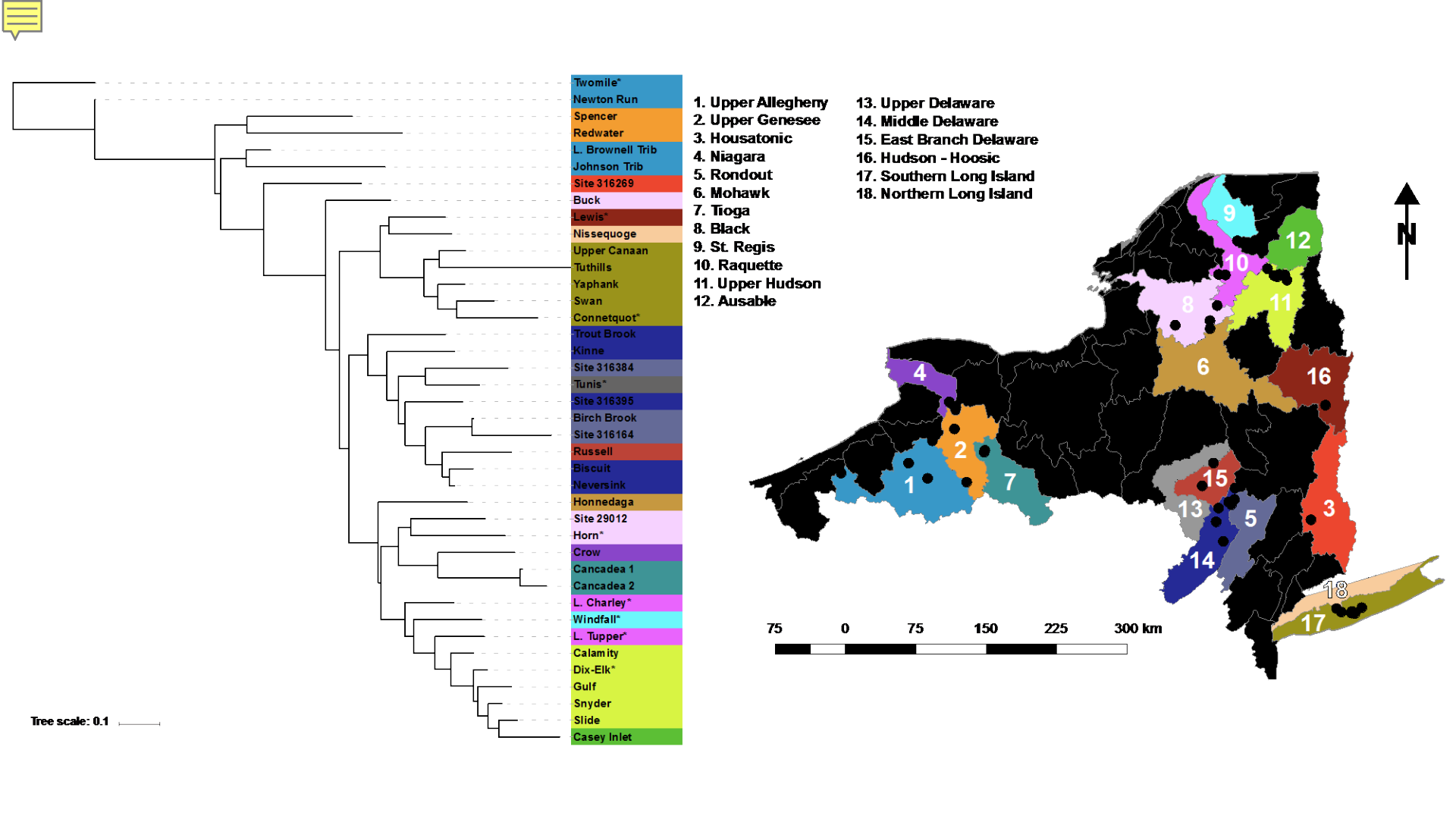
sPCA analysis: Each dot represents an individual fish with colors corresponding to a combination of the 3 principal components. Colors that are more similar represent individuals that are more similar, while colors that are less similar represent individuals that are less similar

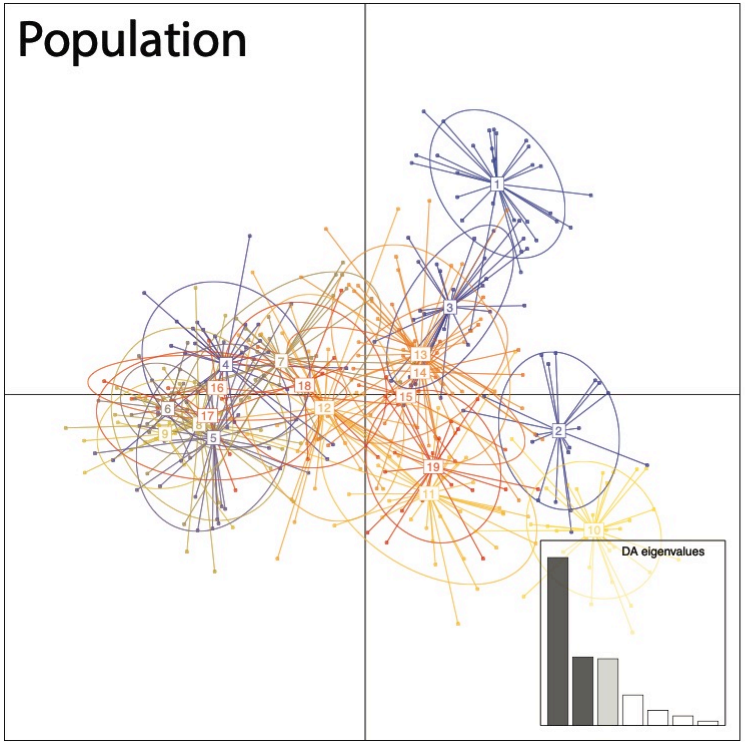
Oswegatchie River – 2018

Uses for sPCA in the context of Brook Trout conservation:

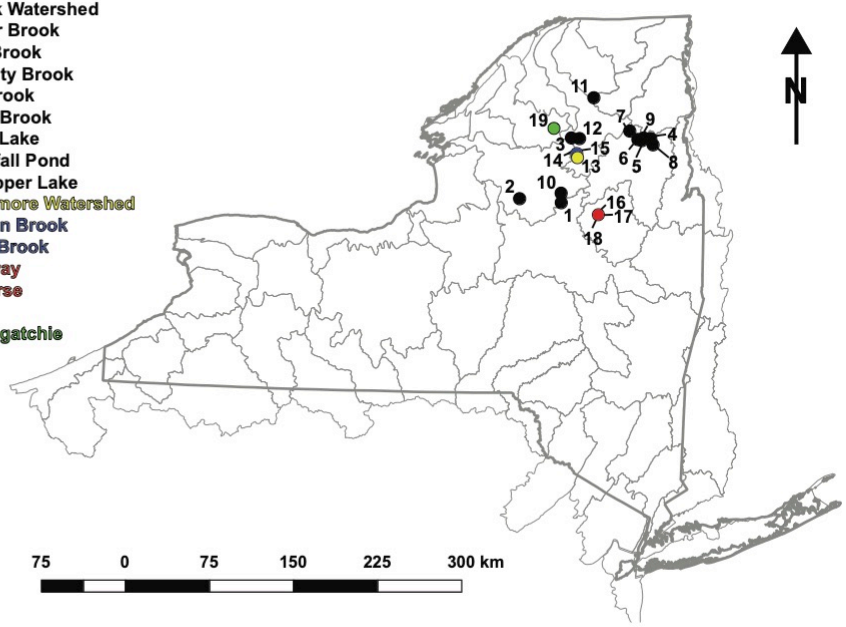
- Diversity Mapping
- Identification of potential barriers restricting movement
- Indicate directional gene flow
- Identify changes in demography over time

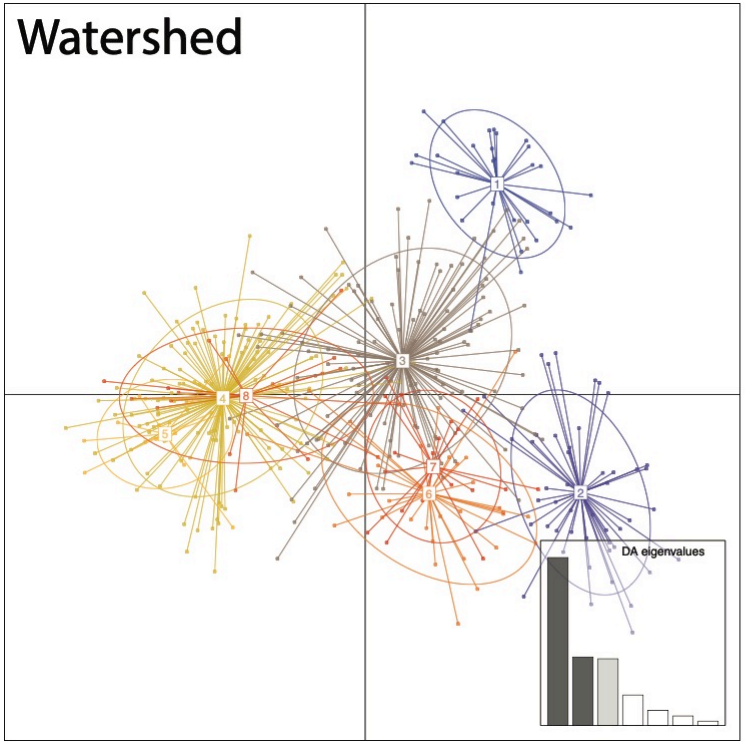



Twomile*
Newton Run
Spencer
Redwater
L. Brownell Trib
Johnson Trib
Site 316269
Buck
Lewis*
Nissequoge
Upper Canaan
Tuthills
Yaphank
Swan
Connetquot*
Trout Brook
Kinne
Site 316384
Tunis*
Site 316395
Birch Brook
Site 316164
Russell
Biscuit
Neversink
Honnedaga
Site 29012
Horn*
Crow
Cancadea 1
Cancadea 2
L. Charley*
Windfall*
L. Tupper*
Calamity
Dix-Elk*
Gulf
Snyder
Slide
Casey Inlet
Tree scale: 0.1
1. Upper Allegheny
2. Upper Genesee
3. Housatonic
4. Niagara
5. Rondout
6. Mohawk
7. Tioga
8. Black
9. St. Regis
10. Raquette
11. Upper Hudson
12. Ausable
13. Upper Delaware
14. Middle Delaware
15. East Branch Delaware
16. Hudson - Hoosic
17. Southern Long Island
18. Northern Long Island
N
75 0 75 150 225 300 km

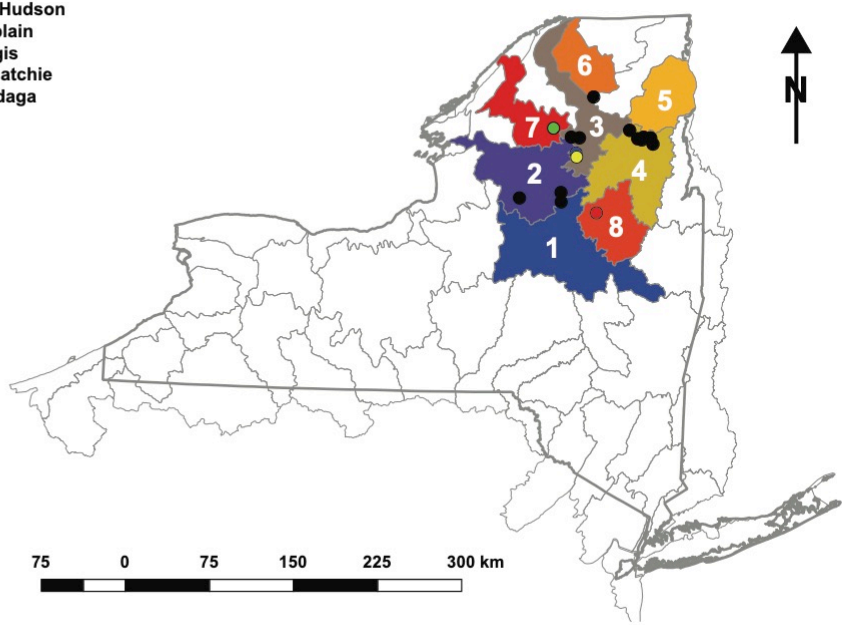


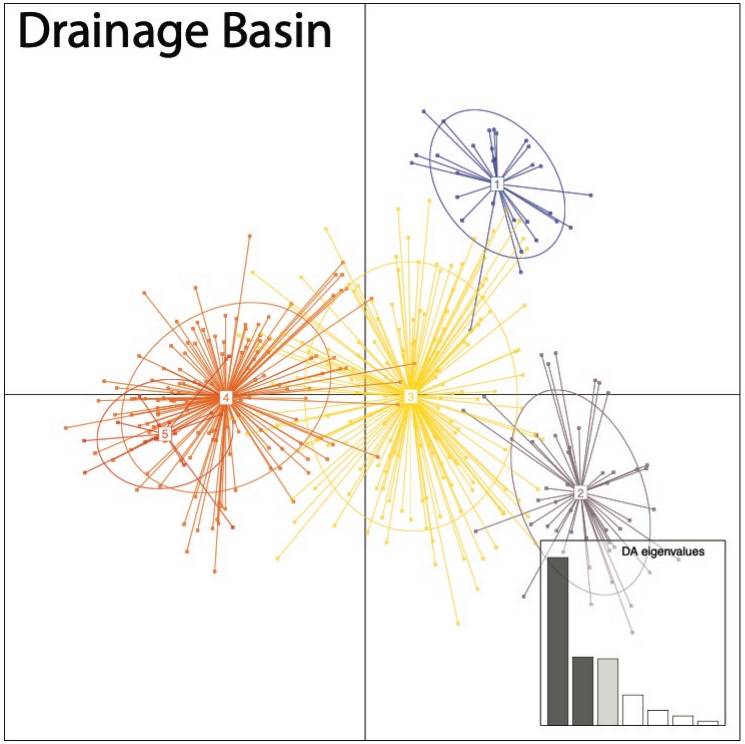
1. Honnedaga
2. Unnamed Brook
3. L. Charley Pond
4. Dix-Elk Watershed
5. Snyder Brook
6. Slide Brook
7. Calamity Brook
8. Gulf Brook
9. Casey Brook
10. Horn Lake
11. Windfall Pond
12. L. Tupper Lake
13. Sagamore Watershed
14. Marion Brook
15. Bear Brook
16. Dugway
17. Devorse
18. Vly
19. Oswegatchie



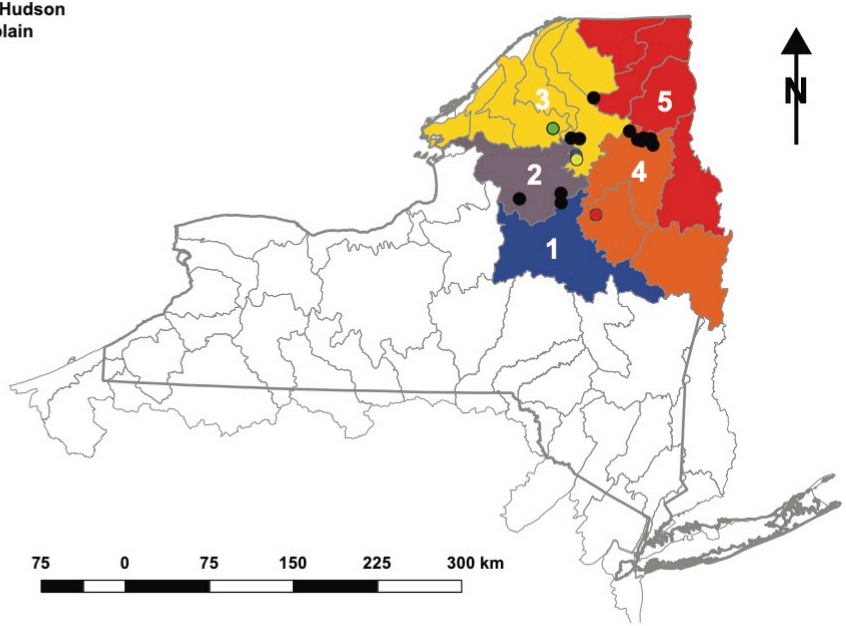


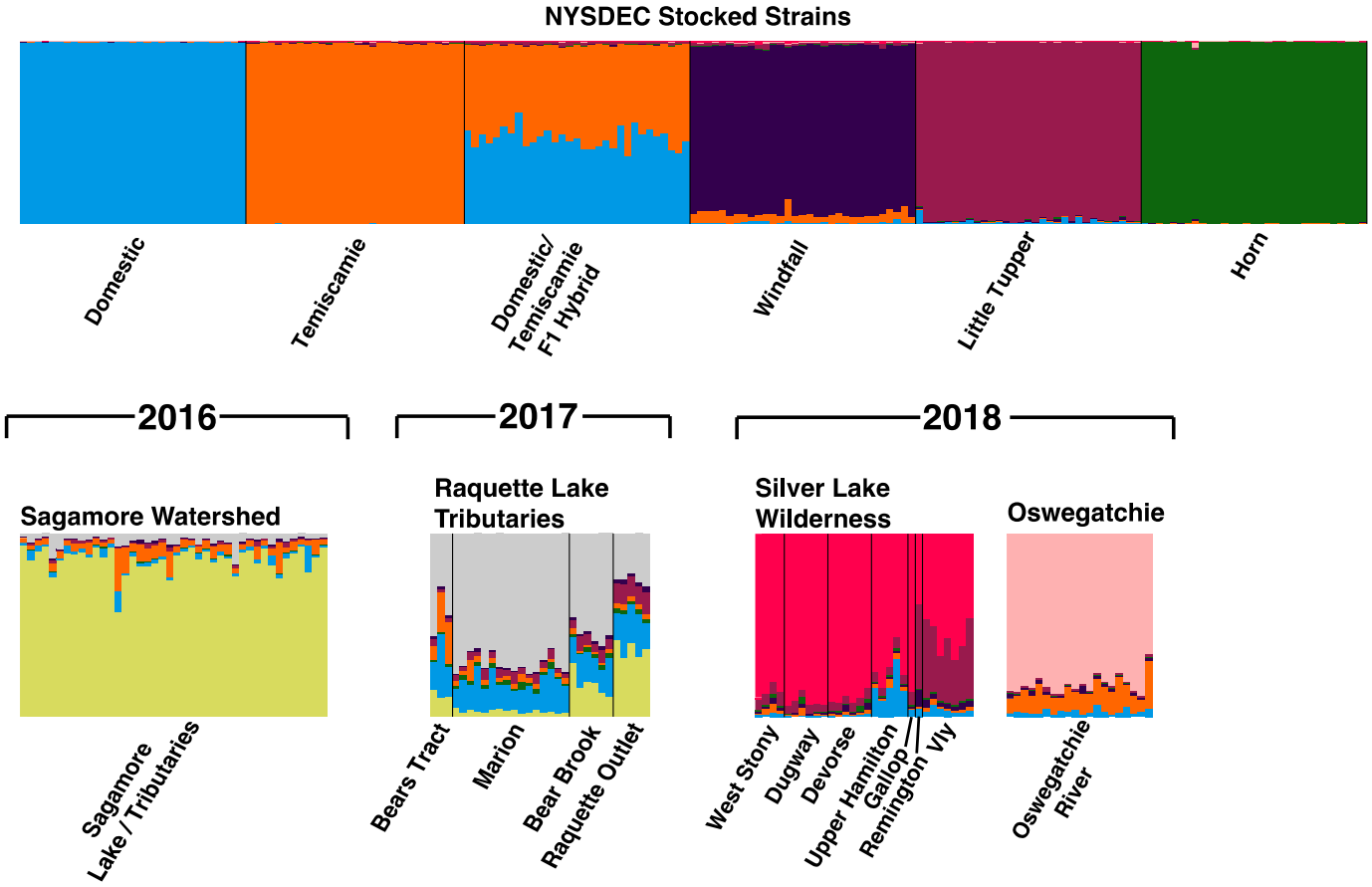
1. Mohawk
2. Black
3. Raquette
4. Upper Hudson
5. Champlain
6. St. Regis
7. Oswegatchie
8. Sacandaga





1. Mohawk
2. Black
3. St. Lawrence
4. Upper Hudson
5. Champlain





STRUCTURE bar plots: Each vertical line in the STRUCTURE plot represents an individual fish, and colors represent their inferred ancestry from 9 different populations.

Conclusions

- The majority of Brook Trout sampled by citizen scientists through Trout Power retain genetic structure consistent with native watershed geography, and offer valuable information in regards to landscape level diversity, gene flow, effective population size, and demographic viability for this species.

- By adding to the increasing body of work elucidating Brook Trout genetic diversity across New York State, the work of Trout Power citizen scientists (and others) suggest that native Brook Trout ancestry in many wild Adirondack waters is likely not an exception, but the norm, leading to a broader discussion about the role of supplemental stocking, and the adaptive potential of this species.

- The nexus of Trout Power Citizen Science motivations Investigation, Education, Action & Conservation merit further inquiry and present intriguing possibilities for engaged science in the Adirondacks and beyond.

Thank you!