Title

Using Survey123 to Map Physical Habitat Characteristics, Watershed Activities, and Disturbances

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Abstract

In this lesson, students are introduced to the idea and practice of “remote sensing” and provided with hands-on, field-based experience using standardized stream habitat assessment protocols (the National Rivers and Streams Assessment [NRSA]), publically available spatial data, and GPS/GIS technology and workflows to develop multi-scale scale profiles of the physical habitat characteristics of a small portion a selected watershed (the exercise can be adapted to focus on any watershed for which high resolution air photos are available). Students will work individually or as a team (e.g. in pairs) to use a Survey123 App adapted from the NRSA protocol for assessing the habitat and physical characteristics – particularly those that have been influenced by human activity – of the riparian area of a stream or river. This lesson requires the instructor to have access to an ArcGIS Online (AGOL) Creator or Editor account and for students to have access to mobile devices with the Survey123 App installed (which will require students to have an AGOL account). A Survey123 App designed for this lesson that can be adapted to suit the instructor’s needs is included in xml format.

Tags/ Keywords

River Field Studies Network; riparian habitat assessment; mapping; GPS; GIS; Survey123; National Rivers and Streams Assessment (NRSA); Remote Sensing

Instructor Notes

- **Target audience Level** - This lesson is designed for introductory level students participating in a river-based field experience early in their academic careers. That said, the lesson may be of interest to more experienced students and can be adapted accordingly.
- **Lesson summary** - Students work individually or as a team (e.g. in pairs) to use a Survey123 App adapted from the National Rivers and Stream Assessment (NRSA) protocol for assessing the habitat and physical characteristics – particularly those that have been influenced by human activity – of the riparian area of a stream or river. The Survey123 App associated with the lesson is built to allow students to enter information ‘on the fly’ – on the water, while paddling, floating, or hiking, as they encounter instances of human influence on the physical habitat of the stream – OR in the context of a more formal lesson in which students are assigned (either individually or as teams) an approximately 0.5km sampling reach within which they use Survey123 to gather information about physical habitat at several transect locations. Depending on the context of the lesson (e.g. whether the lesson is part of a course/ or field experience in which students will have access to the ArcGIS online

(AGOL) and time post-lesson to use AGOL [or desktop GIS software] to analyze the observations collected by the group during the lesson) instructors can choose assess student understanding using a facilitated discussion, short answer responses to questions, or even student development of a more formal GIS-based poster or presentation.

- **Student context factors**
  - **Worldview:** This lesson is designed to introduce students to the NRSA standard categories for classifying stream habitat and human disturbance as well as to mobile-device based data collection systems (Survey123). Depending on a student's worldview, working with these standardized categories and mobile technologies may not (or may) be a familiar or comfortable experience. The lesson offers the opportunity for all students to reflect on how their own experiences shape what they see when they examine riparian landscapes as well as the degree to which the NRSA classification system (and Survey123 interface) include and/or exclude certain landscape features and patterns.
  - **Interests:** This lesson is intended as foundational activity in an introductory level environmental science or geography class, meaning that students will likely have a range of interests in field work, environmental science, geography, and science in general.
  - **Identity:** Students whose sense of place tends to be rooted in cultural tradition and experience may find the relatively rigid NRSA classification system that is embedded in the Survey123 App to be incomplete and/or problematic. For example, such students may feel that the NRSA system fails to capture either the presence or absence (and/or historical or cultural significance or value) of particular attributes of the riparian landscape. Similarly, students whose sense of place tends to be more data driven and/or quantitative may find the NRSA classification system to be more descriptive than quantitative and may wish for the opportunity to measure some of what they observe during the lesson. Regardless of where students 'sit' on the sense of place 'spectrum', students may enjoy the opportunity to interact with and critique the NRSA approach from their own cultural or disciplinary perspective. Through the lesson, the hope is that student experiences during and after the lesson will expand both their understanding of the physical and human attributes of the physical setting of the lesson and, ideally, their sense of place.
  - **Prior knowledge and skills:** Minimal knowledge and skill are needed, though familiarity with mobile device use and settings (e.g. location settings) and workflows for logging in to Apps using credential will be helpful. Some students may struggle with the Survey123 App initially. Practice and patience are key for the instructor and students. For the instructor in particular, practice with the Survey123 App before giving the lesson is essential.
  - **Motivation and expectation:** Students will likely be motivated by the opportunity to paddle or wade in along the banks of the river and to work as a team to gather data. Students may expect the NRSA classification system

embedded in the Survey123 App to allow them to record “all” that they see on the landscape and may become frustrated by the limitations of the NRSA categories to capture the complexity of human influence on the riparian landscape. Instructors should be prepared for this eventuality and it is recommended that instructors visit with the data collection teams during the lesson to encourage them to do their best with the App/ categories and to record their critiques of both in field notes and to raise those points during post-lesson group discussions. Students may be motivated by the opportunity to develop field skills while paddling (or wading) a river or stream. At the same time, students may enjoy the opportunity to learn to use spatial technologies like Survey123 and some basic remote sensing techniques.

- **Prior experiences:** As noted above, prior experiences, skills, and identities will likely shape how students engage with the lesson. Students with GIS experience may find post-lesson GIS work to be less challenging than students who have zero GIS skill. No prior experience with GIS, Survey123, or the NRSA classification is necessary. An assumption of this lesson is that students will have participated in some sort of water safety discussion prior to undertaking the lesson.
- **Personal needs:** Instructors should provide students with a list of necessary gear and be sure they have that gear before setting out to gather data (personal flotation devices, water bottle, mobile device with Survey123 installed and the Survey123 APP for the lesson downloaded, waterproof journal and writing utensil). Instructors should take care to hold a safety briefing prior to students heading out into the field in which they discuss 1) the “boundaries” of the lesson; 2)potentially risky spots in or along the water and how to reduce that risk; 3) when to return to the group; 4) what do do in an emergency; 5) any questions students may have.
- **Approach to engagement:** 5E approach - engage, explore, explain, elaborate, evaluate
    - *Engage* students by asking them to contemplate how they know whether a river is healthy? Then ask them how they think a government agency like the Environmental Protection Agency might go about determining how healthy a river is? Then ask them how they think their own process for determining river health will align with a government agency’s process for determining the same.
    - Have students work in teams to *explore* the riparian zone of a particular stretch of river (the study area for the lesson), using the Survey123 App to gather information about the quality of riparian habitat and human disturbance in the study area.
    - During and after the lesson, encourage students to *explain* their decisions to use (or not use) particular NRSA categories to classify specific landscape features. This can be done as part of a written assignment but it is recommended that it be done in a group debrief session. Similarly,

students should be encouraged to critique the NRSA system and to *explain* their critiques.
        - In a group discussion (or on paper) students should *elaborate* on their explanations of classification decisions and critiques to make suggestions for how the NRSA system could be improved and to contemplate instances where multiple field teams experienced similar classification issues and/or to distill individual teams' critiques and suggestions for improvement into themes that reflect the broader group experience.
        - *Evaluate* students by assigning either versions of the short answer questions provided with the lesson (or short answer questions developed by the instructor) that require students to generate artifacts of their level of engagement with and understanding of the lesson and/or their expanded sense of place regarding the physical setting of the lesson. Alternatively or additionally (circumstances permitting), have students use the Survey123 and ArcGIS online Web Map or Story Map interfaces to create either poster- or slide-style reports or Story Maps on their findings.
- **Logistics and materials needed**
    - This lesson will work best when both the Instructor and students have access to ESRI's ArcGIS Online interfaces AND when students/ survey users use the APP version of the survey (v. the web version of the survey).
    - Students and instructors will need access to mobile devices (with sufficient power supply and an operating system that can support the Survey 123 App).
    - Prior to the lesson - ideally at least one day prior - and while in a place where there is Wifi (recommended) or data connection available, students and instructors should:
        - Download, install, and sign in to the Survey 123 App (See ArcGIS Online Access bullet);
        - Download the Survey 123 App (the survey associated with this lesson) to their devices;
        - Test the App by submitting a 'test' observation (post-lesson, these tests can be filtered out by time-stamp).
    - If the lesson will be used in the context of a class, it is encouraged that instructors create a pre-lesson assignment (due several days before the actual lesson) in which students are required to install the App on their devices and submit a "test" survey. This pre-lesson assignment can be evaluated easily: The instructor can open the Survey on the Survey123 website, click the Data tab, and by scrolling through responses to the "Who Are you?" question, easily give credit/ points to those students who have successfully submitted entries. Similarly, the instructor can reach out to those students who were unable to complete the survey to troubleshoot.
    - ArcGIS Online Access (i.e. an ArcGIS Online account with publishing privileges enabled) is required. Ideally, that access should be part of an organizational license that includes the instructor and the students.

- The instructor will need to download Survey123 (the form survey app for laptop and mobile devices used to capture answers to questions) and Survey123 Connect (used to build and publish XLSForm-based surveys).
- An XLS version of the Survey123 APP is included with the lesson materials. To add the Survey to your account, download and install the Survey123 Connect app, log in using your ArcGIS Online credentials, then follow these instructions to add the Survey. As needed, the Survey can be edited or adapted. Finally, the Survey should be published from the Survey123 Connect App to ArcGIS Survey123 web portal.
- The instructor should then visit the Survey123 web portal (this will require ArcGIS Online credentials), select the Survey (which will open the survey), click the **Collaborate** button, and, under the Share Survey tab, make the following selections
  - Choose "Open the survey in the 123 Field app directly".
  - Choose "Everyone (public)" for Who can submit to this survey?
- Post float/ lesson, Survey123 results can be explored and analyzed using the online ArcGIS Survey123 portal OR desktop GIS software, such as ArcMap or ArcMap Pro. While click-by-click instructions for Post-float/activity analysis are not included in this lesson, links to relevant tutorials are included.

- **Further Reading for the instructor**
  - See the sources below as well as embedded links throughout this lesson
    - EPA (2018). National Rivers and Streams Assessment 2018/19. Field Operations Manual: Non-Wadeable. Version 1.2.
    - EPA (2018). National Rivers and Streams Assessment 2018/19. Appendices. Version 1.2.
  - Digital resources/ references (useful for pre-lesson instructor research and for post-lesson synthesis and discussion).
    - EPA EJ Viewer data/ How's my Watershed
      - https://ejscreen.epa.gov/mapper/
    - NLCD data
      - https://www.mrlc.gov/
      - INTERACTIVE VIEWER - https://www.mrlc.gov/viewer/
        - Experiment w/ CONUS Land Cover Change Index and different vintages of data (e.g. 2019 v. 2001)
    - USDA CropScape
      - https://nassgeodata.gmu.edu/CropScape/
    - Terrain 360
      - https://www.terrain360.com/index.php#3.76/44.49/-95.47
      - This would, theoretically, make it possible to do this exercise virtually

Materials

- **Student Gear**
  - Personal gear
    - personal flotation devices, water bottle
    - sunscreen
    - snacks (tasty)
  - Data collection
    - mobile device with Survey123 installed and the Survey123 APP for the lesson downloaded;
    - waterproof journal and writing utensil
  - Dry bag or heavy duty 1 gallon ziploc bag (to waterproof the maps, journals, devices during the field observation stage)
- **Instructor materials**
  - (strongly recommended, but, ultimately, optional) Maps of aerial imagery/ satellite imagery and land cover in the lesson stretch/ project reach, ideally printed in color, poster size, laminated
    - Imagery options
      - Google Earth imagery (w/ graticule ["grid"] included)
      - NAIP (1m resolution) [Va NAIP download link)
    - Satellite data options
      - Sentinel 2A/B - (10m resolution)
      - Landsat - (30m resolution) – False Infrared band combination
    - NLCD 'map' of land cover/use in the float stretch/ project reach - (30m resolution) [2019 download link]
  - Dry erase marker & eraser (to annotate maps)
  - Printouts (1x student or 1x team) of PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET (FRONT) (A-5)

Learning Outcomes[1]

After completing this activity students will be able to:

- Demonstrate the ability to use the Survey123 App to store spatial and attribute information about watershed characteristics;
- Demonstrate a critical understanding of standardized protocols for assessing watershed characteristics, specifically Appendix B (ppB23-B24) of the *Environmental Protection Agency's (EPA) National Rivers and Streams Assessment (2018/19) Field Operations Manual Non-Wadeable, Version 1.2.*[2]*;*
- Use field observations (gathered through Survey123) to communicate how the spatial resolution and classification systems that underlie field data collection

[1] Assessment questions/ activities can be found in the Reflection Qs section of the lesson, at the end of this document (p.14).

[2] EPA (2018). National Rivers and Streams Assessment 2018/19. Field Operations Manual: Non-Wadeable. Version 1.2. And EPA (2018). National Rivers and Streams Assessment 2018/19. Appendices. Version 1.2.

schema (i.e. the NRSA classification system embedded in the Survey123 App) can affect understandings of riparian habitat quality.

Context for Student

How do we know the state of our country's water resources? How do we know what the key stressors are to our country's river systems? Since 2008, the Environmental Protection Agency (EPA) has, in collaboration with state, Tribal, and regional agencies, developed and utilized the National Rivers and Streams Assessment (NRSA) field operations manuals (for wadeable and non-wadeable stream) to systematically gather data that, theoretically, provides answers to these questions. According to the NRSA, a "core indicator" of the relative health of a river system is the state of the physical habitat in the riparian area. Similarly, the NRSA for non-wadeable streams states that the "physical habitat in streams includes all those physical attributes that influence or provide sustenance to organisms within the stream." (EPA 2018, p. 54). This lesson will provide you with opportunities to use Survey123 to gather field observations adapted from the "physical habitat characterization" section of the EPA's NRSA Field Operations Manuals for Wadeable and Non-Wadeable Streams (2018). In doing so, you will generate baseline information about the "*quality of the riparian habitat that influences the structure and function of the aquatic community*"[3] of a case study watershed. At the same time, the hope is that as you become familiar with using the NRSA protocols to classify and geo-reference different types of habitat and anthropogenic disturbance, you will gain an understanding of strengths and limitations of these protocols and, possibly, come up with some proposals for how the protocols might be improved.

In this project, you will practice with both remote sensing and field-based habitat assessment workflows by:

1) Using Survey123 to gather geo-referenced field observations about sites where human activity within the case study watershed study area may be impacting the structure and function of the river ecosystem (including riparian habitat).
2) (Optional) - Import geo-referenced field observations into a Geographic Information System and prepare a map layout (including captioned overview and zoom views, proper annotation and map elements, and text boxes) that summarizes physical habitat

Prompt/ underlying Research Questions to launch the lesson

1. How healthy is the river that you are studying?
2. What are the distinguishing physical habitat characteristics of the watershed in the project study area?

[3] EPA (2018). National Rivers and Streams Assessment 2018/19. Field Operations Manual: Non-Wadeable. Version 1.2. And EPA (2018). National Rivers and Streams Assessment 2018/19. Appendices. Version 1.2.

3. How might these site specific characteristics shape (and get shaped by) the broader characteristics of the watershed in general?

Data Collection Tasks (to answer the underlying Research Question)

- **Use the Survey123 App to collect data** on Watershed Activities & Disturbances in each transect;
- **Use a field notebook to record additional information** about specific Watershed Activities & Disturbances as well as observations about the limitations or strengths of the NRSA classification system and/or the advantages and disadvantages of the both the Survey 123 App as a data collection platform

Activity

- **Pre-lesson**
  - At least 1 day prior to departure to the field
    - See Logistics and Materials section for detailed instructions on adaptation, use, and distribution of the Survey 123 App
    - Ensure that all students and instructors have Survey 123 installed, the Survey 123 App for the lesson downloaded, and that they have adequate power supply.
- **Group prep (15-30 min)**
  - Identify teams (or individuals)
  - Study area overview and data collection site assignments
    - Instructors should define the overall study area and assign individuals or teams to their specific .5km study reaches (the size of the study reach can be adjusted on the fly).
    - If available, examine large scale, poster-size air photo or similar map of the ‘station’ (the 1-2 km stretch of river where the project will be conducted);
    - If available, study an National Land Cover Database (NLCD) map of the ‘station’ (poster size); Identify and discuss the distinguishing attributes of each NLCD category found in the study area;
    - Using dry erase markers, indicate areas where each group will gather data.
  - (Recommended) Conduct a safety briefing that includes the following elements:
    - Confirm that students have the necessary gear before setting out to gather data
      - personal flotation devices;
      - water bottle;
      - mobile device with Survey123 installed and the Survey123 APP for the lesson downloaded and sufficient battery power;
      - waterproof journal and writing utensil
    - Discussion of
      - the “boundaries” of the lesson;

- potentially risky spots in or along the water and how to reduce that risk;
- where instructors will be during the lesson;
- when to return to the group (rendezvous time);
- what to do in an emergency;
- private v. public land;
- any questions students may have.

- **<u>Study Area and transect location</u>**:
  - The extent of the reach that each pair (or team) of students will assess will be determined in a group meeting led by the instructor(s). Ideally, the put-in location would be on a relatively calm stretch of water that permits upstream and downstream travel by canoes or kayaks (or along the shoreline) piloted by paddlers with river-condition-appropriate boat skills AND, which includes a paddle-able or wadeable tributary. The instructor can and should modify the precise geographies (extents along the river and extents from the water's edge inland) of the overall and team study reaches as needed, based on factors that include safety, the number of students, and time available.
  - Similarly, the instructor can adjust on the fly the number of transects each team needs to sample.
  - The distances below and on the diagram are based on an overall study reach length of 1km along the mainstem of the study area stream in which the 1km overall reach is subdivided into a 0.5km upstream study area (upstream of the put-in point for the exercise) and a 0.5km downstream study area (downstream from the put-in point for the exercise.[4] One team could be assigned responsibility for the entire upstream study area and one to the downstream study area OR multiple teams could be assigned responsibility both. This .5km distance was found to be relatively safe and accessible (instructors [and students] were able to paddle up and downstream in a reasonable amount of time, which allowed the instructor to visit teams, monitor safety, and answer questions and seemed to be an acceptable amount of upstream paddling for students to handle). If a tributary exists within the overall study area, it is recommended that a team be assigned a 0.5 km stretch of that tributary.
  - As a starting point, the extent of the reach that the entire group will sample (all involved in the lesson will sample) will be approximately 0.5 km upstream, 0.5km downstream of the mainstem, and, if a tributary exists, 0.5km up a tributary stream from the site where the lesson is taking place. Individual teams should be assigned a team study reach and be responsible for using the remote sensing and field based-assessment protocols (see below) to gather habitat assessment

[4] Note that the EPA guidance on sample reach length indicates that "*a length of 40 times the wetted width* (i.e. the width of the water in between the streambanks) *is necessary to characterize the habitat and several biotic assemblages associated with the sampling reach*". If the wetted width of the river is <4m, EPA protocols suggest using **150m as a minimum reach length**. If the average wetted width is > 100m, though, the EPA protocols suggest using **4km as a maximum reach length**. (EPA 2018, Nonwadeable p.27-8). For the purposes of this exercise, we will use a .5km reach for our sample reach length.

data from that assigned reach. The initial identification and designation of study reaches for each team will take place with the entire group present.

- **<u>What to do (students):</u>**
  - **Arrive at your assigned reach** and identify your sampling station (transect) locations
    - See Figure 2: Sampling Reach Features [below])
  - **On each side of the stream, use the Survey123 App schema to record Watershed Activities & Disturbances at three transect locations** (6 total sample sites, 3 on each side of the stream):[5]
    - The upper extent of your team's assigned reach (river left and river right).
    - The approximate center of your team's assigned reach (river left and river right).
    - The lower extent of your team's assigned reach(river left and river right).
  - **Use a field notebook to record additional information about:**
    - specific Watershed Activities & Disturbance
    - the limitations or strengths of the NRSA classification system and/or the advantages and disadvantages of the Survey 123 App as a data collection platform
    - Draw a sketch map of sampling reach
  - **Return to the designated rendezvous location at the appointed time.**

[5] Depending on river conditions, you may be unable to cross the river to be physically present in the transect for which you are gathering data. In such a case, you will have to rely on at-a-distance observations and or other resources (e.g. air photos or other spatially referenced information).

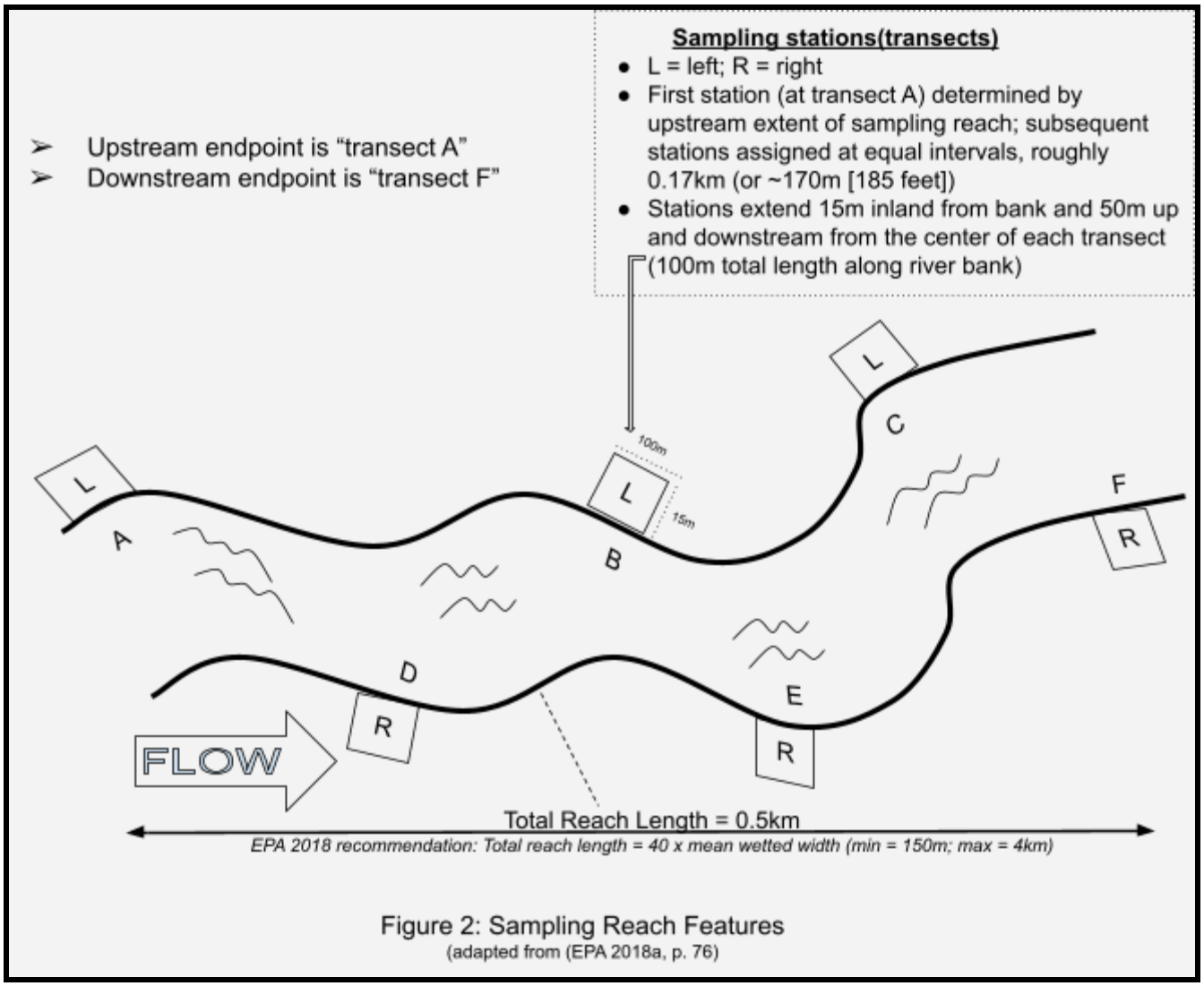


Figure 2: Sampling Reach Features
(adapted from (EPA 2018a, p. 76)

*As indicated in **Figure 2: Sampling Reach Features** (above), each transect should extend approximately 100m along the river bank and approximately 15m inland from the river bank.*[6]

[6] Both distances can be modified at the instructor's discretion.

- Debrief (30-60 min)
  - Optional, but strongly recommended:
    - Each team should annotate laminated posters containing aerial imagery- and NLCS-based maps of the study area to mark a subset of (recommended) or all of their observations.
  - Do this:
    - Hand out copies of the NRSA *PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET* (FRONT) (Appendix A-5, A-6).
  - Discussion 1 - Encourage students to critique (or identify limitations or advantages of) the NRSA system and to *explain* their critiques or arguments.
    - Optional prompt
      - Discuss which physical characteristics included in the NRSA data sheet (but not included in the Survey 123 App nor mapped during the exercise) the group feels are most significant – i.e. 'essential' – to understanding overall watershed viability.
    - Background on the NRSA (for instructor to share with students as needed)
      - Physical Habitat assessment is considered a CORE INDICATOR of river health.
      - The National Rivers and Streams Assessment (NRSA) Field Operations Manual (2018) says that "tidal rivers and streams up to a head of salt (<.5ppt for this study)" are excluded from the NRSA. This may be relevant if this lesson is being used on a tidal section of a river like the James River in Virginia, downstream of Richmond, VA.
      - NRSA Assessment activities are intended to be carried out from the beginning of June through the end of September for most ecoregions, though EPA can approve sampling starting as early as the end of April.
      - NRSA Assessments are intended to be repeated every 5 years or so at the same sites.
      - NRSA Indicators - how they were chosen
        - In consultation w/ state, tribal and regional representatives
        - Key criteria:
          - Indicators had to be applicable on a national scale
          - Indicators should reflect various aspects of ecological condition, repeatabilities, and cost effectiveness
          - Indicators should have known applicability to Clean Water Act programs
    - Discuss possible external sources of this information. For example:

        - the EPA's Environmental Justice Screening and Mapping Tool (which includes links to water quality monitoring data)
        - Mywaterway.epa.gov, the EPA's tool for exploring
        - Cropscape, the United States Department of Agriculture's interactive system for exploring crop type/ land cover;
    - Discuss locations of ideal sites w/in the study area to gather this essential data.
- Discussion 2 - difficulties with classification?
    - Encourage students to *explain* their decisions to use (or not use) particular NRSA categories to classify specific landscape features.
    - Encourage students to *elaborate* on their explanations of classification decisions and critiques to make suggestions for how the NRSA system could be improved
    - Facilitate a conversation that permits the group to contemplate instances where multiple field teams experienced similar classification issues and/or to distill individual teams' critiques and suggestions for improvement into themes that reflect the broader group experience.
- Discussion 3 - Discuss 'lingering questions' raised by the exercise.

Reflection Qs - Short Answer (to be trimmed/ adapted as the instructor sees fit)

1. What are the distinguishing physical habitat characteristics of the watershed in the project study area and how might these site specific characteristics shape (and get shaped by) the broader characteristics of the watershed in general?
2. Describe the main patterns of human activity and disturbance that were observed in your study reach?
    a. Which activities or disturbances are/were more or less common than others?
    b. Describe the location of these activities/ disturbances relative to other features (e.g. to main roads, urban areas, protected areas, industrial zones).
3. List and explain (and/or diagram) 2-3 ways that the activities or disturbances you observed may affect the structure and function of the aquatic ecosystem in the vicinity of your study area/ reach.
4. Based on your observations, would you argue that the stretch of river you observed is healthy? Why or why not?
5. Compare what field observations of the physical characteristics of the watershed at the study area scale suggest about the geography and magnitude of potential threats to the overall resilience of the watershed to what spatial data at larger scales (e.g. aerial imagery or NLCD land cover maps) suggests about the same.
6. Identify and explain at least two challenges to expanding the on-the-ground data collection element of this lesson from an assessment of the specific study area to include a larger chunk of territory (or the entire watershed)?
    a. How might these challenges be overcome?
7. The NRSA guidance on sample reach length for physical habitat characteristics assessment indicates that "*a length of 40 times the wetted width* (i.e. the width of the water in between the streambanks) *is necessary to characterize the habitat and several biotic assemblages associated with the sampling reach*". If the wetted width of the river is <4m, EPA protocols suggest using **150m as a minimum reach length**. If the average wetted width is > 100m, though, the NRSA protocols suggest using **4km as a maximum reach length**. (EPA 2018, Nonwadeable p.27-8). For the purposes of this exercise, we used a 1km stretch of river for our sample reach length.
    a. What length of reach should you have sampled (based on the NRSA guidance? What logistical changes/ considerations would have to be addressed in order to sample a reach this size?
    b. What patterns of human activity/ disturbance might your team have encountered at the 'proper' reach size that you didn't encounter at the .5km reach size? What patterns of human activity that you observed in your .5km reach would likely also be present in the 'proper' reach?
8. In what ways did the geographic parameters of the data collection (e.g. reach size/ extent; transect length and distance from water) influence what you were able to observe/ gather data on? Were there any human activities/ disturbances that you feel were/ are relevant that were 'outside' of your sampling area (and therefore, excluded from your data collection)?

9. How does the length of your study area/ reach affect what types/ patterns of human activity/ disturbance you observed? As you respond to this question, be sure to address the following points:
    a. As a starting point, when it comes to selecting the reach to be selected, the EPA's bioassessment protocols (2005) suggests either a 100m reach "or other reach designation [e.g. 40 x stream wetted width]".
    b. Approximately how wide is the river/ stream at the site that you sampled?
    c. Using the 40x stream wetted width suggestion, how long should your study area reach have been (in order to align with the 40x stream wetted width standard)?
        - *For example, If you were doing this project in Virginia on the James River at the VCU Rice River Center site, the river there is approximately 2.3km wide. Using the 40x stream wetted width suggestion, this would mean that the sampling reach would need to be approximately 92 km (57 miles) in length.*
    d. What patterns of human activity/ disturbance might have been visible at this scale (the length you calculated for point c, above)?
    e. What patterns of human activity/ disturbance might have been invisible?
10. How might historical imagery inform our understanding of how riparian land use – not just in the 15m transect zone extent, but say 2-3 km from stream channel – may affect the river (and its tributaries)
    a. Tip: Use Google Earth Pro's historical imagery tool to explore how land use in the vicinity of study area for this lesson has changed over time.
11. What sorts of challenges did the questions about stream character present? How did your team deal with/ overcome/ cope with these challenges?
12. Were there any aspects of the riparian habitat that your team felt were significant but which were not captured by the Survey123 data collection schema? How could these aspects of riparian habitat be better assessed/ captured?
13. What challenges did you and your team experience in trying to assess physical habitat on both sides of the river? How did you overcome these challenges? E.g. how did you determine the extent of each transect and/ or your study reach?

GIS-based Synthesis; Data Analysis (Optional: in the computer lab/ on a laptop with Google Earth and ArcMap installed, and with Internet connection and access to Survey123 results)

1. Explore Survey123 results via the Survey123 Analyze & Data tabs
2. In ArcMap, import the Survey123 results, and explore spatial relationships between field data gathered using Survey123 and additional spatial/ contextual data, such as:
    a. NLCD data
    b. NAIP imagery
    c. EPA spatial data (e.g. NPDES permit holders; data from How's my watershed)

    d. Stage agency spatial data (e.g. Virginia's Environmental Data Hub; Montana's Department of Environmental Quality spatial data)
3. Use ArcGIS Online to create a Story Map-based report on the lesson experience/ findings.

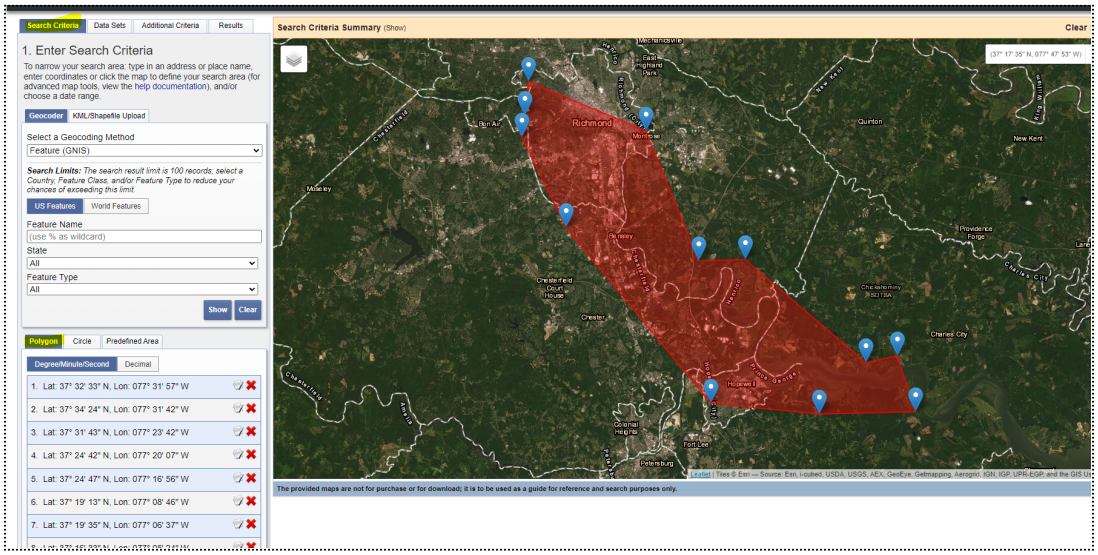
Assessment

Outcome	Assessment Artifact	Attributes of a '10' score
Demonstrate the ability to use GPS devices and/or Apps (e.g. Survey123) to store spatial and attribute information about watershed characteristics	Authored (based on initials entered) Survey123 entries	Survey123 entries are complete and technically accurate (locations marked correspond to actual surface conditions); Contextual information is included for all entries (text responses); Contextual information adds additional meaningful information to entries; Contextual information effectively directs attention to or raises questions about observed physical habitat patterns; Entries include images and captions that facilitate image interpretation.
Demonstrate a critical understanding of standardized protocols for assessing watershed characteristics, specifically Appendix B (ppB23-B24) of the *National Rivers and Streams Assessment (NRSA) (2018/19) Field Operations Manual Non-Wadeable, Version 1.2.*[7]	Responses to short answer Qs	Responses mention specific criteria and/or elements of the NRSA protocol; Responses include multiple (at least 3) examples of instances where the NRSA protocol and/or sampling (transect) parameters were problematic;
Use field observations (GPS points and map annotation) to communicate how the spatial resolution (pixel size) of remotely sensed data and field observations – and the scale/ spatial parameters of the sampling protocol – can affect understandings of riparian habitat quality.	Responses to short answer Qs	Responses specifically invoke the concept of scale (whether in terms of the scale of the study area, the sampling protocol, or spatial resolution of imagery or NLCD maps) to raise questions about the degree to which the NRSA protocol generates data that do, in fact, improve our understandings of riparian habitat quality; Responses provide multiple examples (at least 2) of instances or sites where the scale of the sampling protocol resulted in the exclusion (or inclusion) of features that might significantly affect/ alter understandings of riparian habitat.

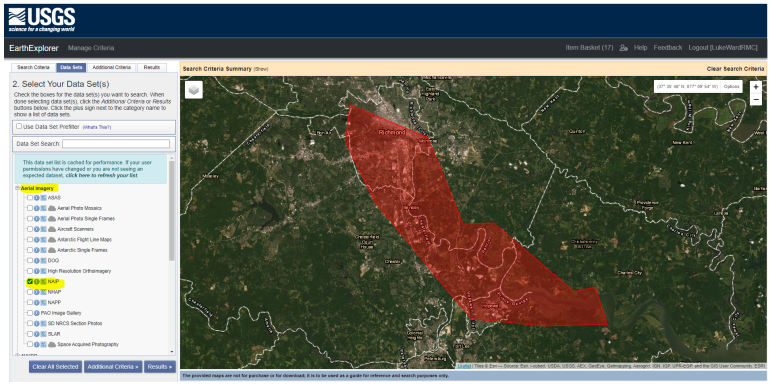
[7] EPA (2018). National Rivers and Streams Assessment 2018/19. Field Operations Manual: Non-Wadeable. Version 1.2. And EPA (2018). National Rivers and Streams Assessment 2018/19. Appendices. Version 1.2.

Appendix1 - NAIP imagery acquisition

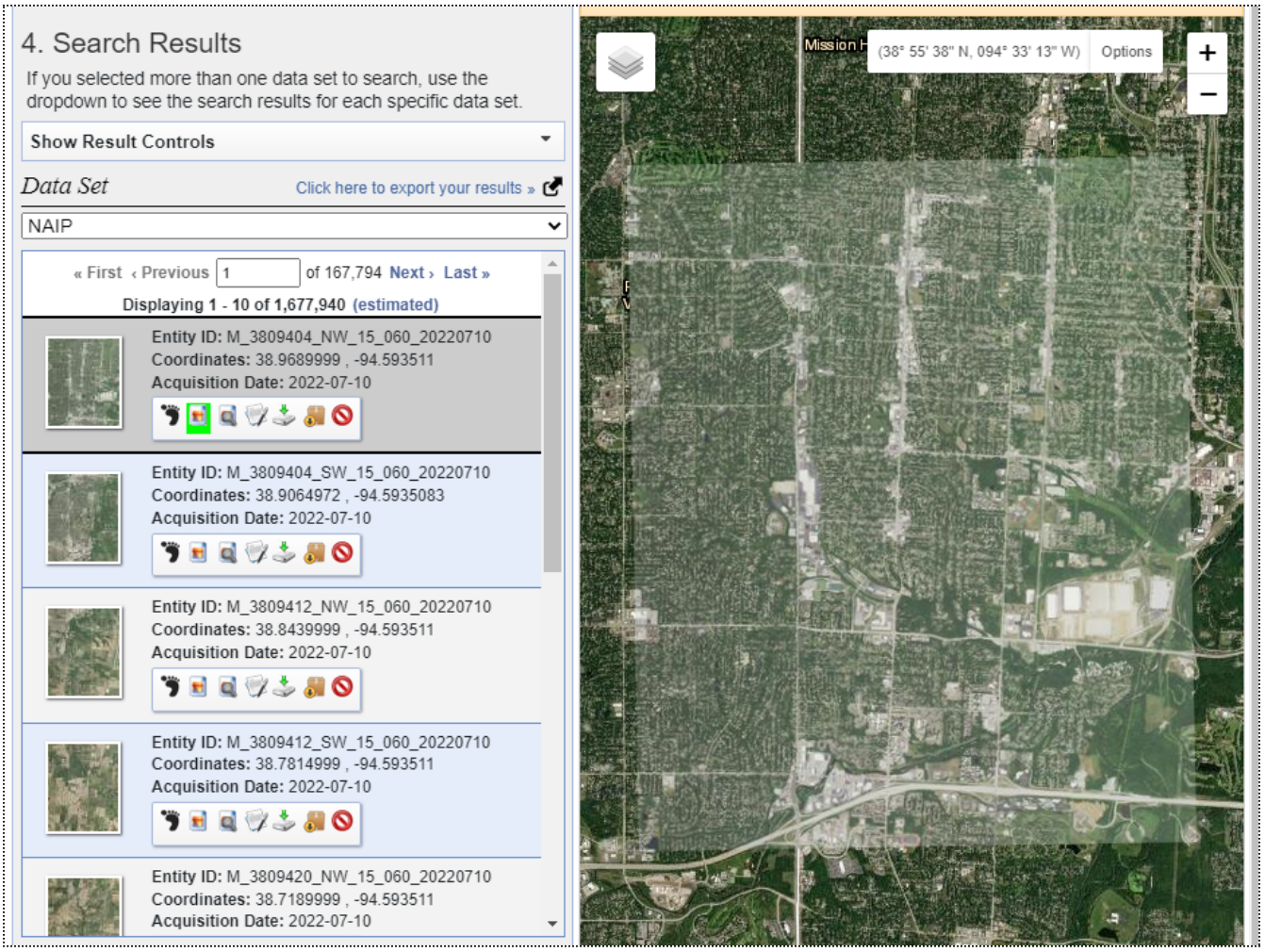
1. Visit the USGS's Earth Explorer website
2. Be sure to log in to the website. If you do not have a login, create an account, then login
3. Click the **Search Criteria** tab and specify the geographic extent of your study area and the vintage (data range) of the NAIP imagery you are interested in downloading.
    a. Choose the Geographic Extent
        i. Polygon option
            1. Click the **Polygon** tab (the tab will turn blue when selected)
            2. Click on the map to drop points representing the geographic extent of your study area(see image below
        ii. Map extent option
            1. Pan the map to the extent you are interested in. Click the **Use Map Extent** button.
    b. Choose the Date Range
        i. In both the from and to boxes, either enter the dates manually or click the calendar.



4. Click the **Datasets** tab, choose Aerial Imagery, Check the box next to NAIP



5. Click the **Results** button
    a. A **Search Results** tab opens
6. Preview and download the NAIP imagery
    a. Roll over each of the **Search Results** and the button adjacent to each thumbnail.
        i. Click the **Show Browse Overlay** button (highlighted in green below) to previous the extent of the available imagery.
    b. Click the **Download Options** button (green arrow pointing down to a white rectangular shape).
        i. Choose the desired file/ option to download.



Appendix 2: NRSA Procedure overview.

PROCEDURE FOR PERFORMING HABITAT ASSESSMENT

1. Select the reach to be assessed. The habitat assessment is performed on the same 100 m reach (or other reach designation [e.g., 40 x stream wetted width]) from which the biological sampling is conducted. Some parameters require an observation of a broader section of the catchment than just the sampling reach.

2. Complete the station identification section of each field data sheet and habitat assessment form.

3. It is best for the investigators to obtain a close look at the habitat features to make an adequate assessment. If the physical and water quality characterization and habitat assessment are done before the biological sampling, care must be taken to avoid disturbing the sampling habitat.

4. Complete the **Physical Characterization and Water Quality Field Data Sheet**. Sketch a map of the sampling reach on the back of this form.

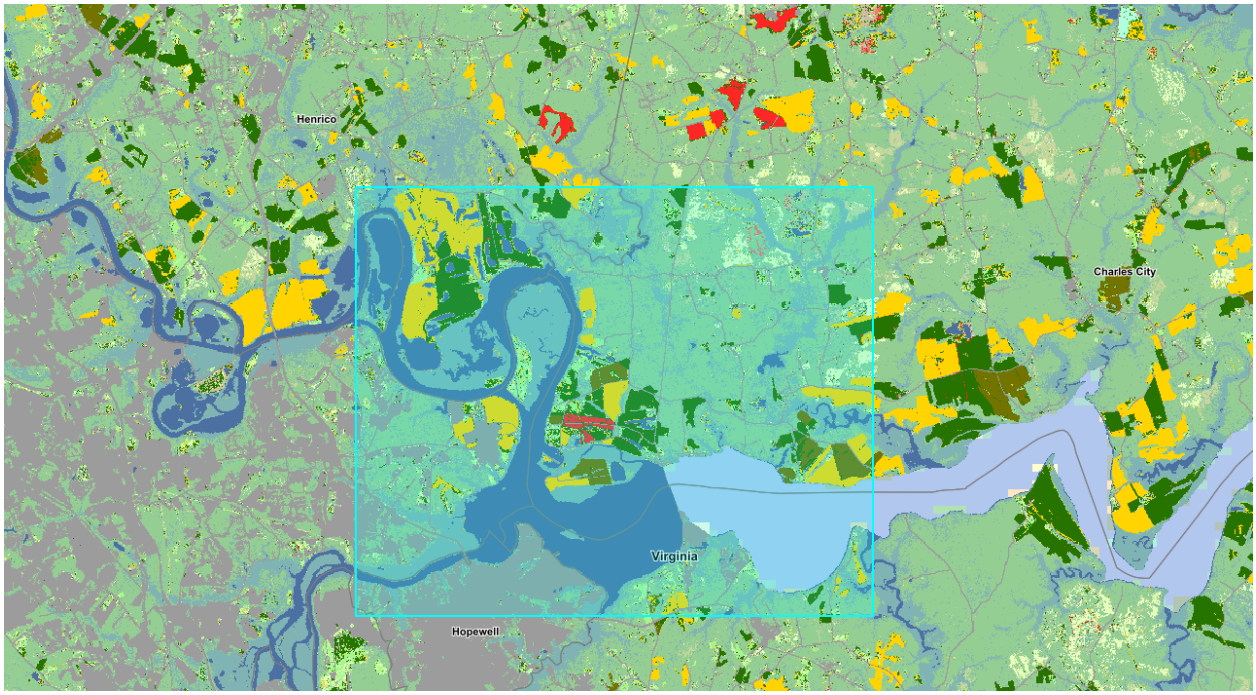
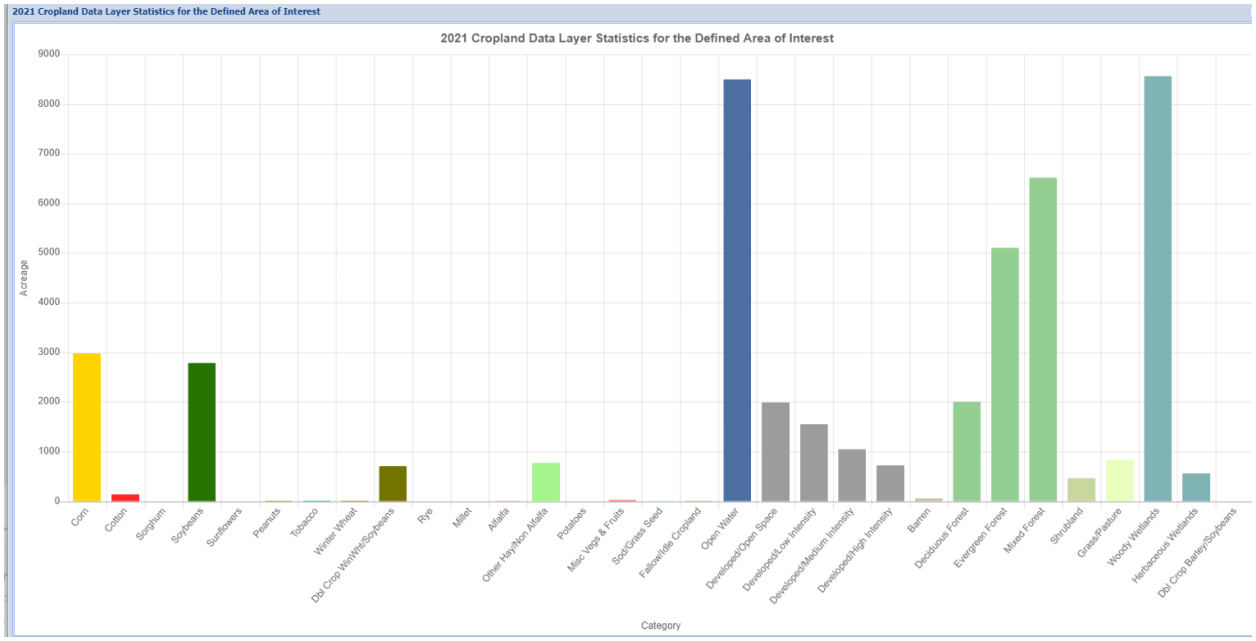
5. Complete the **Habitat Assessment Field Data Sheet**, in a team of 2 or more biologists, if possible, to come to a consensus on determination of quality. Those parameters to be evaluated on a scale greater than a sampling reach require traversing the stream corridor to the extent deemed necessary to assess the habitat feature. As a general rule-of-thumb, use 2 lengths of the sampling reach to assess these parameters.

QUALITY ASSURANCE PROCEDURES

1. Each biologist is to be trained in the visual-based habitat assessment technique for the applicable region or state.

2. The judgment criteria for each habitat parameter are calibrated for the stream classes under study. Some text modifications may be needed on a regional basis.

3. Periodic checks of assessment results are completed using pictures of the sampling reach and discussions among the biologists in the agency.

Appendix 3 - Cropscape view in the vicinity of the VCU Rice River Center, on the James River, downstream of Richmond

- Blue rectangle on the map shows an are area of interest;
- Graph below shows the statistics (acreage) for landcover/ crop types inside of the area of interest.