Appendix A: Assumptions Codebook

Use this coding scheme for conversations about or artifacts that capture the project leaders' assumptions about volunteers' skill proficiency.

Code	Description	Example (Inclusion and exclusion, if necessary)
Have skills	Instances in which project leaders make statements about the skills they "think" or "believe" volunteers do or not have when they start participating in the citizen science project. Statements project leaders make about training in relation to these skills.	Because it's such a voluntary program, people opt in because of a connection to content [i.e., they are already interested in the topic]....When we are expecting people to opt in from the content side, perhaps we take some shortcuts [with our training], which may be problematic.
Practice makes perfect	Instances in which project leaders make statements about the skills they "think" or "believe" volunteers gain or improve through their participation in the citizen science project	"What we think ... [is by] doing [this] through time, you get better at noticing the [animal]."

Appendix B: Notice Relevant Features Template

How to Develop an Embedded Assessment for *Notice Relevant Features*

INTRODUCTION

Purpose: This embedded assessment (EA) can be used to assess the ability of volunteers to perform the skill: *Notice relevant features*.

Definition: The skill for *notice relevant features* is related to what Eberbach and Crowley (2009) define as: "noticing," which they describe as "*[using] existing knowledge to notice and organize key features that support inferences about deep principles and relationships within biological systems."* That is, an observer is able to match what they see with their content knowledge. Examples provided in this document focus on linking "relevant features" of species with a classification system. In the context of citizen science, a volunteer could *notice* floral structure and connect what they see with what they know about characteristics of different plant families; they could then use this information to identify a particular plant.

The Assessment: One way to assess this skill in an embedded way is to provide volunteers with photos of the target species under field conditions. These photos should be shot from the perspective of a volunteer collecting data (i.e., first person). Next, a questionnaire should be created that includes questions relevant to noticing relevant features. For example, the volunteer might be asked what features they looked for and how they knew to look for these features. Finally, a scoring sheet, or rubric, should be created that describes high to low levels of the skill *notice relevant features*. To implement this EA, the volunteer will be asked to review the photos and complete the questionnaire; then a staff will score the results to determine the volunteer's skill proficiency. In the next section, we provide a specific example of how to create an EA for this skill, which includes examples of:

- Checklist for Identifying Relevant Features and Corresponding Photos
- Example questionnaire (Google Forms) for Notice Relevant Features - Michigan Butterfly Network
- Scoring Instructions for Notice Relevant Features - Michigan Butterfly Network
- Example Scoring Sheet for Notice Relevant Features - Michigan Butterfly Network

Checklist for Identifying Relevant Features and Corresponding Photos

Relevant Features
Identify up to three diagnostic features that volunteers would need to recognize in order to either distinguish the animal from the background environment, or accurately identify the organism at a prescribed taxonomic level, such as species or whatever is most appropriate for your project (e.g. specific color(s), body traits, habitat, etc).

Relevant Feature #1: _____

Relevant Feature #2: _____

Relevant Feature #3: _____

Finding Photos/Examples
Now find photos that you might already have in stock (or real-world examples from your project site) that highlight that diagnostic feature OR a lack of a diagnostic feature.

Feel free to offer more than one photo/example for each, and please specify how it is an exemplar:

- Photo/example that highlights relevant feature #1 (e.g. has an organism in a less noticeable place)
- Photo/example without relevant feature #1 (e.g. flying insect that is yellow and black, but not a bee)
- Photo/example that highlights relevant feature #2
- Photo/example without relevant feature #2
- Photo/example that highlights relevant feature #3
- Photo/example without relevant feature #3

Create the embedded assessment in Google Forms (or preferred format)

Would you like access to a premade Google Form template? Use the QR code below to visit our website and contact us to request a copy.

Example Scoring Instructions for *Notice Relevant Features - Michigan Butterfly Network*

Volunteer Self-Description

1. *How long have you participated in the Michigan Butterfly Network?*
   Score 1 if they choose “”This is my first season.”
   Score 2 if they choose “2-3 seasons”
   Score 3 if they choose “More than 3 seasons”

2. Do you consider yourself an expert in identifying butterflies?
   Score 1 if they choose “definitely not”
   Score 2 if they choose “I’m pretty good”
   Score 3 if they choose “Expert of professional”

Picture #1

1. *Is this: Butterfly, Moth, Another insect, Not sure?* [Correct answer = “butterfly”]
   Score 1 point for “Butterfly”
   Score 0 points for “Moth”, “Another insect” or “Not sure”

2. *What features of the animal did you use to decide if it was a butterfly, moth, or another insect?* [0-3 points]
   Score up to 2 points: Required/necessary features (either one is sufficient)
      Thin antennae with club-shaped tips
      Wings folded up while at rest

   Score up to 1 more point for any optional features (relevant, but ONLY score points if a required feature above is mentioned)
      Slender and smooth body

   Score 0: Irrelevant features
      Size
      Color pattern
      General look of it

Picture #2

3. *Is this: Butterfly, Moth, Another insect, Not sure* [Correct answer=”moth”]
   Score 1 point for “moth”
   Score 0 points for “butterfly”, “Another insect” or “Not sure”

4. *What features of the animal did you use to decide if it was a butterfly, moth or another insect?* [0-3 points]

Score up to 2 points: Required/necessary features (either one is sufficient)

Feathery or comb-like antennae

Flattened wings while at rest

Score up to 1 more point for any optional features (relevant, but ONLY score points if a required feature above is mentioned)

Stout and fuzzy body

Score 0: Irrelevant feature

Color pattern

Size

General look of it

Picture #3

5. *What type of butterfly is this?* [Correct answer "Eastern Tiger Swallowtail"]

Score a 1 if they checked Eastern Tiger Swallowtail

Score a 0 For all other answers (i.e. black swallowtail, spicebush swallowtail, not sure, other)

6. *What features of the butterfly did you use to decide the type?*

Score up to 1 point: Required/necessary features

Bright yellow with broad black stripes

Score up to 1 more point for any optional features (relevant, but ONLY score points if a required feature above is mentioned)

Presence of "tails"

Large Size

Picture #4

7. *What type of butterfly is this?* [Correct answer = American Lady]

Score a 1 if they checked american lady

Score a 0 For all other answers (i.e. Painted Lady, Red Admiral, Not Sure, Other)

8. *What features of the butterfly did you use to decide the type?*

Score up to 1 point: Required/necessary features

Two large eyespots on underside of the hindwing

Score up to 1 more point for any optional features (relevant, but ONLY score points if a required feature above is mentioned)

Medium size

Red coloration

Picture #5 (for Relevant Feature #3: ID age characteristics; features present)

9. What type of butterfly is this? [Correct answer = Great Spangled Fritillary]

Score a 1 if they checked Great Spangled Fritillary

Score a 0 For all other answers (i.e. Monarch, Painted Lady, Not Sure, Other)

10. What features of the butterfly did you use to decide the type?

Score up to 1 point: Required/necessary features

Underside of hindwing with creamy submarginal band and large silver spots

Score up to 2 more points for optional features (relevant, but ONLY score points if a required feature above is mentioned)

Orange coloration

Large size

Example Scoring Sheet for Notice Relevant Features - Michigan Butterfly Network

(correct answers in parentheses in "Scoring Instructions" column)

Question	Score	Scoring Instructions
Volunteer self-identification		
How long have you participated in the Michigan Butterfly Network?	No score	1 if "This is my first season"; 2 if "2-3 seasons"; 3 if "More than 3 seasons"
Do you consider yourself an expert in identifying butterflies?	No score	1 if "Definitely not"; 2 if "I'm pretty good" 3 if "Expert of professional"
PICTURE #1		
Is this: butterfly, mother, another insect, not sure	0/ 1	0 if "another insect", unsure, or not entered;1 if correct answer: "butterfly"
What features of the animal did you use to decide if it was a bee or another insect?	0-3	
PICTURE #2		
Is this: butterfly, moth, another insect, not sure	0/ 1	0 if incorrect, unsure, or not entered;1 if correct
What features of the animal did you use to decide if it was a bee or another insect?	0-3	
PICTURE #3		
What type of butterfly is this: black swallowtail, eastern tiger swallowtail, spicebush swallowtail, not sure, other	0/ 1	0 if incorrect, unsure, or not entered;1 if correct (eastern tiger swallowtail)
What features of the animal did you use to decide the type?	0-3	
PICTURE #4		
What type of butterfly is this: American Lady, Painted Lady, Red Admiral, not sure, other	0/ 1	0 if incorrect, unsure, or not entered;1 if correct (American Lady)
What features of the animal did you use to decide the type? [1 point per correct feature mentioned]	0-3	
PICTURE #5		
What type of butterfly is this: great spangled	0/ 1	0 if incorrect, unsure, or not entered;1 if correct

fritillary, monarch, painted lady, not sure, other		(great spangled fritillary)
What features of the butterfly did you use to decide the type? [1 point per correct feature]	0-3	
Total Score out of 20 =		

Appendix C: Recording Standard Observations Template

How to Develop an Embedded Assessment (EA) for *Recording Standard Observations*

INTRODUCTION

Purpose: The goal of this embedded assessment (EA) is to create a simulation or short video (3-5 minutes), such that someone watching the video can accurately record observations from the video onto a data collection form specifically created for the video. The simulation can serve as an additional training tool and alert you to areas in your protocol where mistakes might be made by participants.

Definition: We define "standard observations" as those that provide a consistent or uniform set of measures to describe a phenomenon or event, using a standard unit that can be duplicated or shared by all observers. For this embedded assessment, we focus on four categories of standard observations: *Spatial, Temporal, Biological, and Environmental.* We include these four categories as they are commonly recorded in environmental citizen science projects. If your project does not gather information on one or more of these categories, do not include them in your EA.

The Assessment: The assessment is meant to determine whether an adult volunteer can accurately record standard observations, not whether they do so consistently within the parameters of the citizen science project. This assessment uses a simulation approach in that videos are shot from the perspective of a volunteer collecting data (i.e., first person) to "simulate" recording standard observations in the field. A modified data sheet can be created for participants to record their observations as they watch the video simulation. We also provide templates for scoring sheets to assess volunteers' performance in recording standard observations.

CONTENTS

- **How to Create the Video**
- **Checklist for Video Production**
- **Example Data Sheet**
- **Example Scoring Sheet**

How to Create the Video

Using a camera phone or some other video recording device, create a short video (3-5 minutes) as if you are going through the data collection process, from the perspective of the data collector. This will look different for each project. Narration of tasks should NOT be included. You should shoot videos at a time when you are likely to observe the species/phenomena of interest (e.g., after a rainstorm to hear frogs, flowers in bloom, etc.).

A. **Introductory narration:** At the start of the video, include a graphic or screen capture of your project and record a one-minute audio introduction of the project. See Box 1, below for a template of the introductory script.

BOX 1: Script for Intro Narration

[PROJECT NAME] is a citizen science project designed to [INSERT MAIN SCIENCE GOAL OF PROJECT].

IN A FEW SENTENCES DESCRIBE WHY THIS PROJECT IS IMPORTANT

NEXT, BRIEFLY DESCRIBE HOW DATA ARE COLLECTED FOR YOUR PROJECT.

You are about to see a [X MINUTE] video of someone in the field gathering data on the [INSERT TAXA INFORMATION AT THE SPECIFICITY REQUIRED]. This video is being developed as an additional training tool for [PROJECT NAME] participants.

"As you watch this short video, use the data sheet provided to you to follow along and record observations as if you were the one collecting the data."

You will be asked to record information about [TIME, LOCATION, ENVIRONMENTAL CONDITIONS AND INSERT BIOLOGICAL DATA].

If, at any time during your observation, you are unsure of what you see or what the question is asking, indicate you are unsure on the data sheet. [PROVIDE ADDITIONAL INSTRUCTION ABOUT WHAT CONSTITUTES A COMPLETE RECORDING OR WHAT THEY SHOULD NOT WORRY ABOUT IN THE RECORDING].

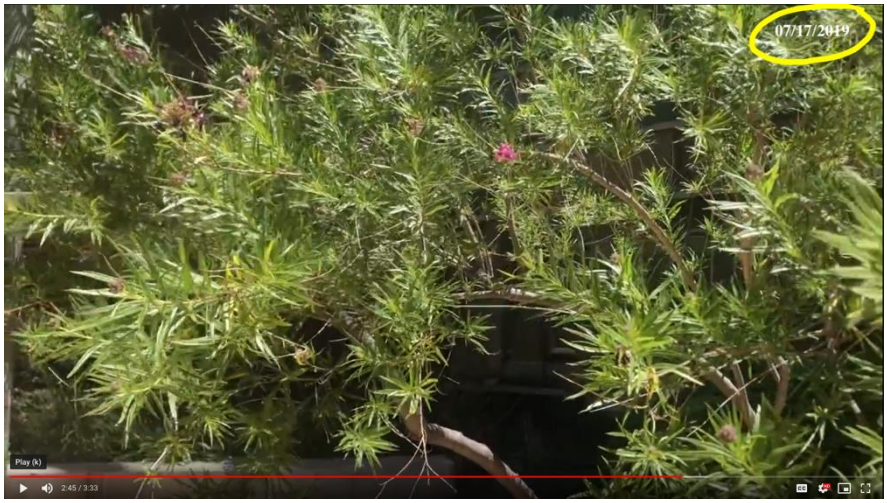
If you need to pause or rewind, you may do so. [THIS DEPENDS ON THE PROJECT]

Let's begin.

[AFTER THE VIDEO] "Thank you for recording your observations for [PROJECT NAME], please submit your information to…"

B. **Location Information:** If relevant, include in the video (rather than in the audio narration), a text-based location stamp somewhere on the video, as shown by the circle in the image below. The location information text should reflect the way in which your project collects location information (e.g., city, state; lat/long, habitat type, etc).

C. **Temporal (time) Information:** If relevant, include on the video (rather than in the audio narration), a text-based timestamp somewhere on the video, as shown in the image below.



D. **Environmental conditions:** If the protocol calls for inclusion of environmental conditions such as temperature, wind speed, precipitation, depth of snow cover or cloud cover, is this information evident from the video? If not, embed necessary information on the screen.

E. **Biological data:** Citizen science biological data come in numerous forms. Please be sure to include the relevant biological information in the clearest, simplest way. This shouldn't be used as a

challenging test, but rather it should attempt to simulate the typical data collection environment as much as possible. Things to consider when making your video:

1. Are the species in question clearly visible/audible, especially if they are moving?
2. If the protocol calls for counting, are individual species distinguishable enough?
3. If protocol calls for identification of phenophases, can you zoom in close enough to accurately distinguish those?
4. If protocol calls for estimating height, width, or size, is there something in the frame that can provide scale?

F. **Distractors:** You may consider including 1 or 2 “distractors” in your video. Distractors are defined as things that make it harder to observe and record accurate data, or typical mistakes that people make that prevent them from recording accurate data. For example, there might be butterflies that are not in the data collection frame of reference and thus should not be recorded (i.e., butterflies observed too far ahead or behind the observer). Distractors can potentially alert you to common mistakes people make, but they may also be harder to score and analyze.

Other criteria for creating high-quality video:

- Is there correct/sufficient detail provided to accurately record information?
- Is the video recorded in color (HD preferred, but not necessary)?
- Is the video recorded at eye level?
- Is video recorded using the correct frame of reference (i.e., 360 degree view or 180 degree)?
- Is audio turned off, unless the protocol calls for it?
- Is video saved on a publicly accessible site?

Refining the video with colleagues: Once a draft of the video is complete, you should share it with several colleagues who are familiar with the protocol and ask them to enter data from the video onto the data collection worksheet created for each project (see Appendix B: Nature’s Notebook Data Collection Worksheet Example). If aspects of the video are confusing or missing, continue refining the video until colleagues can accurately record data onto the modified worksheet.

Recruiting Participants: When you are ready to recruit participants to take part in the simulation, provide them with a link to the video and either a paper or electronic version of a modified data sheet. See Michigan Butterfly Network example data sheet. Reiterate to participants that this is not a test, but rather a training tool. You may also want to get their feedback on the tool itself. You should decide whether you will allow participants to use the rewind or pause button during the video. This might make sense for projects collecting information on stationary organisms (e.g., plants). If your project is observing organisms in motion, it makes sense to NOT pause or rewind the video, to mimic the real-time nature of non-stationary organisms and make the assessment more authentic to the data collection experience.

Scoring the Assessment: The assessment is scored based on correct and incorrect responses. For example, for location, time, and environmental conditions questions, scoring might be as simple as a "1" and a "0" for wrong or incomplete answers. Biological data questions, which are more challenging to answer, might be scored with greater weight. For instance, a "2" for correct answers, a "1" for partial correct answers (e.g., genus level, but not species), and a "0" for unsure, wrong, or incomplete answers.

A higher score would indicate higher accuracy and completion in recording standardized observations. Project leaders can use the scoring tool to determine how well participants understand the protocol, including distractors, and where additional instruction or training may be necessary. See example of a Scoring Sheet from the Michigan Butterfly Network.

Checklist for Video Production for Recording Standardized Observations

☑☑ Introductory Narration

Did you provide ample information about what, why, and how to use this video?

☑☑ Location Information:

Describe Location Information to be entered and where (timestamp or range) it is found in the video. Enter N/A if not applicable.

_____

☑☑ Time Information:

Describe Time information to be entered and where it is found in the video. Enter N/A if not applicable.

_____

☑☑ Environmental conditions:

Describe what, if any, environmental conditions should be entered and where it is found in the video. Enter N/A if not applicable.

_____

☑☑ Biological Observations:

Describe which biological observations should be entered and the timestamp or range of time where they are found in the video:

_____

☑☑ Distractors: If you included distractors, complete the information below. Include the timestamp where it is found in the video

Distractor #1: _____
Why is it a distractor? _____
_____

Distractor #2: _____
Why is it a distractor? _____
_____

Example Data Sheet

for *Michigan Butterfly Network*

Volunteer Self- Description

A. How long have you participated in the Michigan Butterfly Network? (Circle one)

This is my first season. 2-3 seasons More than 3 seasons

B. Do you consider yourself an expert in identifying butterflies? (Circle one)

Definitely not I'm pretty good Expert of professional

Please review the data collection protocol. Then, click the link to watch a video on recording observations for the Michigan Butterfly Network. As you watch the video, answer the following questions as completely as possible.

1. Location where video is recorded: _____

2. Date when video was recorded (mm/dd/yy): _____

3. Start time: _____

4. End time: _____

5. Sky (Circle one)

Clear (<10% cover)
Mostly clear (10-30%)
Partly cloudy (40-60%)
Mostly Cloudy (70-80%)
Overcast (90-100%)
Hazy

6. As you watch the video, please tally the number of butterflies you see. When done, please enter the total number for each identified and unidentified butterfly.

Hesperiidae	**Skippers**	**Tally**	**Total**
Epargyreus clarus	Silver-spotted Skipper		
Erynnis juvenalis	Juvenal's Duskywing		
Thymelicus lineola	European Skipper		
Euphyes vestris	Dun Skipper		

Anatrytone logan	Delaware Skipper		
Papilionidae	**Swallowtails**		
Papilio cresphontes	Giant Swallowtail		
Papilio polyxenes	Black Swallowtail		
Papilio glaucus	Eastern Tiger Swallowtail		
Papilio troilus	Spicebush Swallowtail		
Pieridae	**Whites and Sulphurs**		
Pieris rapae	Cabbage White		
Colias eurytheme	Orange Sulphur		
Colias philodice	Clouded Sulphur		
Lycaenidae	**Gossamer-wing**		
Lycaena phlaeas	American Copper		
Satyrium titus	Coral Hairstreak		
Satyrium edwardsii	Edward's Hairstreak		
Cupido comyntas	Eastern Tailed Blue		
Celastrina ladon/neglecta	Spring/Summer Azure		
Glaucopsyche lygdamus	Silvery Blue		
Nymphalidae	**Brushfoots**		
Danaus plexippus	Monarch		
Speyeria cybele	Great Spangled Fritillary		
Boloria selene	Silver-bordered Fritillary		
Boloria bellona	Meadow Fritillary		
Speyeria aphrodite	Aphrodite Fritillary		
Coenonympha tullia	Common Ringlet		
Limenitis archippus	Viceroy		

L. arthemis astyanax	Red-spotted Purple		
Nymphalis antiopa	Mourning Cloak		
Euphydryas phaeton	Baltimore Checkerspot		
Phyciodes tharos	Pearl Crescent		
Polygonia interrogationis	Question Mark		
Polygonia comma	Eastern Comma		
Polygonia progne	Grey Comma		
Red Admiral	Red Admiral		
Painted Lady	Painted Lady		
American Painted Lady	American Painted Lady		
Hackberry Emperor	Hackberry Emperor		
Junonia coenia	Buckeye		
Satryidae Satyrs	**Wood Nymphs**		
Enodia anthedon	Northern Pearly Eye		
Satyrodes appalachia	Appalachian Brown		
Satyrodes eurydice	Eyed Brown		
Megisto cymela	Little Wood Satyr		
Cercyonis pegala	Common Wood-Nymph		
Others			
Polygonia Species	Unidentified Anglewing		
Polyommatinae Species	Unidentified Blue		
Butterfly Species	Unidentified Butterfly		
Lycaeninae Species	Unidentified Copper		
Speyeria Species	Unidentified Greater Fritillary		
Boloria Species	Unidentified Lesser Fritillary		

Hesperiidae Species	Unidentified Skipper		
Coliadinae Species	Unidentified Sulphur		
Papilioninae Species	Unidentified Swallowtail		
Nymphalidae Species	Unidentified Brushfoot		

Scoring Sheet for Michigan Butterfly Network

(correct answers in parentheses in “Comments” column)

Volunteer Self- Description	**Score**	
How long have you participated in the Michigan Butterfly Network?	**1/2/3**	1 if This is my first season, 2 if 2-3 seasons, and 3 if More than 3 seasons
Do you consider yourself an expert in identifying butterflies?	**1/2/3**	1 if Definitely not, 2 if I’m pretty good, and 3 if Expert of professional
Question	**Score**	**Comments**
Location where video is recorded	0 / 1	0 if unsure, not entered or incorrect; 1 if correct
Date when video is recorded	0 / 1	0 if unsure, not entered or incorrect; 1 if correct (1 =
Start time	0 / 1	0 if unsure, not entered or incorrect; 1 if correct (1 =
End time	0 / 1	0 if unsure, not entered or incorrect; 1 if correct (1 =
Sky	0 / 1	0 if unsure, not entered or incorrect; 1 if correct (1 = mostly clear)
TOTAL (UP TO 5)		

3 points for each correct species level identification: (up to 12 points)		
		Giant Swallowtail
		Eastern Tiger Swallowtail
		Pearl Crescent
		Painted Lady

2 points for each correct family level identification: (up to 10 points)		
		Unidentified Swallowtail (2x2)
		Unidentified Brushfoot (2X2)
		Unidentified Blue
1 point for counting all the butterflies in the video: (up to 5)		
		Butterfly
TOTAL (UP TO 12)		
Grand total from top and bottom (up to 17)		