Background: Stream salamanders are vulnerable to decline across their range due to increasing number of threats associated with climate change and land use development. Numerous management agencies and conservation organizations are interested in protecting these species through managing riparian and upland habitats and barriers that influence predatory fish dispersal. Regional data sets that are useful for predicting both local and broad-scale catchment-scale salamander occupancy in relation to changing abiotic and biotic factors are limited. As a result, management agencies are turning to stream salamander experts to help inform the potential benefits of alternative conservation actions using formalized expert elicitation methods.

Purpose: The purpose of this survey is to utilize salamander expertise to understand the effects of a variety of factors hypothesized to influence occupancy of several species of stream salamanders at the local (catchment) scale. Using information across multiple experts can allow for estimation of uncertainty in predictions of occupancy under alternative land management strategies.

Species: Short paragraph listing the three species in the elicitation. Brief stream salamander species descriptions (what needs to be included here?; table?). Appendix A.

**STEP 1. TAKE THIS SURVEY.** To the best of your ability, please answer the nine questions below. To assist you, we have provided a list of publications (Appendix A) and strongly encourage participants to review this list and consult them in your survey responses. Please email your completed survey to [rakatz@umass.edu](mailto:rakatz@umass.edu) by X date.

**STEP 2: PARTICIPATE FOLLOW-UP WEBINAR.** We will follow up two weeks (week of X) with a webinar to share results (anonymously) with other experts. Using the Delphi survey method, we will encourage discussion among experts in relation to survey responses.

**STEP 3: AMEND SURVEY RESPONSES.** We will then allow each expert to amend their responses and indicate their confidence in their responses, as we want to ensure that expert opinions are an accurate representation of the current state of the knowledge.

Figure 1. Figure of a 100-m reach within a catchment (i.e., an HUC10 drainage with each catchment throughout with hydrolines). In this figure, we’ll point to each covariate to describe what they mean (i.e., riparian, upland, reach/catchment, temperature, flow, etc).

**Question 1:** **Biographical Information**

Name:

Email:

Affiliation:

Graduation Year (Ph.D.):

Years conducting research on stream salamanders:

Estimated number of publications on stream salamanders:

In your opinion, please tell us what your current state of knowledge of stream salamanders by placing an “X” in each category below to indicate if you have no knowledge (1), less knowledge (2), similar knowledge (3), more knowledge (4), or the most knowledge (5) ***in relation to all other amphibian ecologists***. For example, if you consider yourself to have a similar amount of knowledge in the field of riparian effects on salamanders to the rest of the experts, place an “X” in category 3. Also, please indicate the number of publications you have co-authored relevant to each category.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Level of knowledge | 1  (no knowledge) | 2  (less knowledge) | 3  (similar knowledge) | 4  (more knowledge) | 5  (most knowledge) | number  of publications |
| General salamander ecology |  |  |  |  |  |  |
| Land use effects on salamanders |  |  |  |  |  |  |
| Riparian buffer effects on salamanders |  |  |  |  |  |  |
| Stream temperature effects on salamanders |  |  |  |  |  |  |
| Streamflow effects on salamanders |  |  |  |  |  |  |
| Fish effects on salamanders |  |  |  |  |  |  |
| Salamander effects on fish |  |  |  |  |  |  |
| Salamander occupancy modeling |  |  |  |  |  |  |
| Salamander abundance modeling |  |  |  |  |  |  |

**Question 2: Overall average probability of occupancy (grand mean intercept; b0)**

In your opinion, how many stream reaches (100-m length) out of 100 (each randomly selected from across the entire species range) would you expect to contain a populations of salamanders for each species below?

For this question, imagine that all randomly selected reaches have the following characteristics:

* drainage area of 3 km2 (approximately 2.5 m wetted width),
* mean summer stream temperature of 16O C
* average annual flow regimes (non-drought or flood year)
* 100% forest cover within a 30-m riparian zone
* 50% forest cover within the upland (non-riparian zone)
* contains no populations of predatory fish
* network position? (we’ll use a random effect of HUC or can calculate/elicit network stats)
* elevation? (correlated with stream temp/forest cover/catchment size?)

DEFU \_\_\_\_\_\_\_ [value between 0 and 100]

GYPO \_\_\_\_\_\_\_ [value between 0 and 100]

EUBI \_\_\_\_\_\_\_ [value between 0 and 100]

**Question 3.** **Stream size (b1)**

In your opinion, how many stream reaches (100-m length) out of 100 reaches (each randomly selected from across the entire species range) of a similar **STREAM SIZE (drainage area)** would you expect a populations of salamanders to exist for each species (DEFU, GYPO, EUBI)?

Assume that all randomly selected reaches have the following characteristics:

* mean summer stream temperature of 16o C
* average annual flow regimes (non drought or flood year)
* 100% forest cover within a 30-m riparian zone
* 50% forest cover within the upland (non-riparian)
* contain no predatory fish

Note the change the change in drainage area and stream width (units increase). Values should be between 0 and 100 in EACH box.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Number of possible  stream reaches | Drainage area (km2) | Wetted stream width (m) | DEFU | GYPO | EUBI |
| 100 | 0.75 | 0.5 |  |  |  |
| 100 | 1.00 | 1.0 |  |  |  |
| 100 | 2.00 | 2.0 |  |  |  |
| 100 | 3.00 | 2.5 |  |  |  |
| 100 | 4.00 | 3.0 |  |  |  |
| 100 | 5.00 | 3.5 |  |  |  |
| 100 | 10.00 | 4.0 |  |  |  |
| 100 | 15.00 | 5.0 |  |  |  |
| 100 | 40.00 | 8.0 |  |  |  |
| 100 | 200.00 | 20.0 |  |  |  |

**Question 4.** **Stream temperature (b2)**

In your opinion, how many stream reaches (100-m length) out of 100 reaches (each randomly selected from across the entire species range) of a similar **STREAM TEMPERATURE (mean summer water temperature, C)** would you expect a populations of salamanders to exist for each species (DEFU, GYPO, EUBI)?

Assume all reaches have:

* upstream drainage area of 3 km2 (approximately 2.5 m wetted width),
* average annual flow regimes (non-drought or flood year)
* 100% forest cover within a 30-m riparian zone
* 50% forest cover within the upland (non-riparian)
* contain no predatory fish

Note the change the stream temperature is 1 unit (2 degrees).

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Number of possible stream reaches | Mean summer  stream temperature (C) | DEFU | GYPO | EUBI |
| 100 | 10 |  |  |  |
| 100 | 12 |  |  |  |
| 100 | 14 |  |  |  |
| 100 | 16 |  |  |  |
| 100 | 18 |  |  |  |
| 100 | 20 |  |  |  |
| 100 | 22 |  |  |  |
| 100 | 24 |  |  |  |
| 100 | 26 |  |  |  |
| 100 | 28 |  |  |  |
| 100 | 30 |  |  |  |
| 100 | 34 |  |  |  |
| 100 | 36 |  |  |  |
| 100 | 38 |  |  |  |

**Question 5.** **Streamflow (b3) – (interaction term between precip x drainage - like Q6?)**

In your opinion, how many stream reaches (100-m length) out of 100 reaches (each randomly selected from across the entire species range) with a similar **STREAMFLOW REGIME (drought, normal, flood year)** would you expect a populations of salamanders to exist for each species (DEFU, GYPO, EUBI)?

Assume all reaches have:

* 100% forest cover within a 30-m riparian zone
* 50% forest cover within the upland (non-riparian)
* contain no predatory fish

100 possible reaches for each box (max = 900 reaches per species)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| DEFU |  | Precipitation | | |
|  |  | drought year | normal year | flood year |
| Stream size | 1 km2 ~ 1 m |  |  |  |
| 10 km2 ~ 4 m |  |  |  |
| 50 km2 ~ 10 m |  |  |  |
| GYPO |  | Precipitation | | |
|  |  | drought year | normal year | flood year |
| Stream size | 1 km2 ~ 1 m |  |  |  |
| 10 km2 ~ 4 m |  |  |  |
| 50 km2 ~ 10 m |  |  |  |
| EUBI |  | Precipitation | | |
|  |  | drought year | normal year | flood year |
| Stream size | 1 km2 ~ 1 m |  |  |  |
| 10 km2 ~ 4 m |  |  |  |
| 50 km2 ~ 10 m |  |  |  |

**Question 6.** **Riparian and upland forest cover (b4 and b5)**

In your opinion, how many stream reaches out (100-m length) of 100 reaches (each randomly selected from across the entire species range) with a similar **FOREST COVER (riparian and upland percent forest cover)** would you expect a populations of salamanders to exist for each species (DEFU, GYPO, EUBI)?

Assume all reaches have:

* drainage area of 3 km2 (approximately 2.5 m wetted width),
* mean summer stream temperature of 16o C
* average annual flow regimes (non drought or flood year)
* contain no predatory fish

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| DEFU |  | Percent upland (non-riparian) forest cover | | |
|  |  | 0 | 50 | 100 |
| Percent riparian  (30-m buffer) forest cover | 0 |  |  |  |
| 50 |  |  |  |
| 100 |  |  |  |
| GYPO |  | Percent upland (non-riparian) forest cover | | |
|  |  | 0 | 50 | 100 |
| Percent riparian  (30-m buffer) forest cover | 0 |  |  |  |
| 50 |  |  |  |
| 100 |  |  |  |
| EUBI |  | Percent upland (non-riparian) forest cover | | |
|  |  | 0 | 50 | 100 |
| Percent riparian  (30-m buffer) forest cover | 0 |  |  |  |
| 50 |  |  |  |
| 100 |  |  |  |

**Question 7:** **Fish presence (b6)**

In your opinion, how many stream reaches out (100-m length) of 100 reaches (each randomly selected from across the entire species range) with a similar **FISH PRESENCE (resident population of brook trout present)** would you expect a populations of salamanders to exist for each species (DEFU, GYPO, EUBI)?

Assume all reaches have:

* drainage area of 3 km2 (approximately 2.5 m wetted width),
* mean summer stream temperature of 16o C
* average annual flow regimes (non drought or flood year)
* 100% forest cover within a 30-m riparian zone
* 50% forest cover within the upland (non-riparian)

All reaches have a brook trout population (refer to Q2; no fish baseline if needed).

DEFU \_\_\_\_\_\_\_ [value between 0 and 100]

GYPO \_\_\_\_\_\_\_ [value between 0 and 100]

EUBI \_\_\_\_\_\_\_ [value between 0 and 100]

**Question 8: Additional factors influencing occupancy**

Additional factors likely also influence stream salamander occupancy. To the best of your knowledge, list any additional factors that you expect to be more influential than those listed in above questions 2-7 and the direction of the influence reach-level/catchment-level salamander occupancy.

1. Factor description: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Circle one: **positive** (increase) **negative** (decrease)

1. Factor description: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Circle one: **positive** (increase) **negative** (decrease)

1. Factor description: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Circle one: **positive** (increase) **negative** (decrease)

1. Factor description: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Circle one: **positive** (increase) **negative** (decrease)

1. Factor description: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Circle one: **positive** (increase) **negative** (decrease)

**Question 9: Additional experts**

In your opinion, are there additional stream salamander who could answer any of the questions above with more confidence than yourself?

Question (2-7): \_\_\_\_\_\_\_\_\_\_\_\_ Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Question (2-7): \_\_\_\_\_\_\_\_\_\_\_\_ Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Question (2-7): \_\_\_\_\_\_\_\_\_\_\_\_ Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Question (2-7): \_\_\_\_\_\_\_\_\_\_\_\_ Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Question (2-7): \_\_\_\_\_\_\_\_\_\_\_\_ Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Appendix B. List of experts requested to take this survey.

[NEARMI opinions]

Dan and Evan - enter 1 = yes considered expert for this study

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| last | first | affiliation | | Use? (1= yes,  (0 = no) | gen\_eco | landuse | riparian | temp | fish | flow | occ | abun |
| Adams | Dean |  | |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Adams | Mike | USGS | |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Apodoca | JJ |  | |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Baily | Larissa | ColoradoState |  | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Barrett | Kyle | Clemson | |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beachy | Chris |  | |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Bonett | Ron |  | |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Bruce | Dick |  | |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Calhoun | Aram |  | |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Camp | Carola |  | |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Cecala | Kristen | Sewanee | |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| David | Robert |  | |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Earl | Julia |  | |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Fields | Will | USGS | |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Gorman | Tom |  | |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Graham | Sean |  | |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Grant | Evan | USGS | |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Greenwald | Katie |  | |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Harper | Elizabeth |  | |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Highton | Dick |  | |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Hill | Pierson |  | |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Hocking | Dan | USGS | |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Homyack | Jessica |  | |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Houck | Lynne |  | |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Hunter | Malcom |  | |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Jaeger | Bob |  | |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Kozak | Ken |  | |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Kroll | AJ |  | |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Lips | Karen | UMaryland | |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Lowe | Winsor |  | |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Maerz | John | UGA | |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Mendelson | Joe |  | |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Milanovich | Joe |  | |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Miller | David | PennState | |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Muths | Erin | USGS | |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| O’Connell | Katie |  | |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Patrick | David |  | |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Pauley | Tom |  | |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Peterman | Bill |  | |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Pierson | Todd |  | |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Rissler | Leslie |  | |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Scott | David |  | |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steen | David | Auburn | |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Stuart | X |  | |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Sutton | Bill |  | |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Tilley | Stephen |  | |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Titus | Valorie |  | |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Trauth | Stan |  | |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Wake | David |  | |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Walls | Susan |  | |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Welsh | Hartwell |  | |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |