SUPPLEMENTARY INFORMATION

# Innovation diffusion within large environmental NGOs through informal network agents

## Supplementary notes

### Invitation, registration, and tutorial process

Three emails were sent to primary invitees. All subject of each email was "Attention: Human Well-being and Conservation Guidance Tutorial", "Reminder: Human Well-being and Conservation Guidance Tutorial", and "Final reminder: Human Well-being and Conservation Guidance Tutorial" for the first, second, and third emails, respectively. Supplementary Figure 1 presents the invitation email sent to boundary spanners and randomly selected non-boundary spanners. The invitation employs a number of tactics to increase the likelihood that respondents diffuse and register for the tutorial. Supplementary Figure 2 presents the trajectory of each email. The first and third emails had the longest duration of email opens, while the staff largely stopped opening the second email within six hours. Once staff registered and attended the webinar, they were automatically enrolled in the human well-being and conservation tutorial and received the email in Supplementary Figure 3.

### Blocking for the proportion of informal boundary spanners

Supplementary Figure 4 presents a histogram for the proportion of informal boundary spanners in an OU. The blue line in Supplementary Figure 4 presents the overall median. From the histogram we can see that the proportion is largely similar across OUs up until the median.

### Generating the organizational hierarchy variable

We used individual-level supervisor data to generate the organizational hierarchy of staff in the entire TNC NAR. Supplementary Figure 5 presents the steps for generating the hierarchy variable. The hierarchy variable ranges from 1-11. Each individual has one supervisor, and each supervisor may manage multiple individuals. We first assigned individuals with no supervisee a value of one. Individuals with at least one supervisee are temporarily assigned a value of two. We then examined whether individuals temporarily at hierarchy two had any supervisees also at hierarchy two. Individuals who only had supervisee(s) at hierarchy one were assigned two for the hierarchy variable. This process was repeated until all of the supervisees below the individual had been assigned a hierarchy value. Individuals at the highest level in the organizational hierarchy were staff that had no supervisor above them. For example, Bob has two supervisees, Bill and Alice. Bill has no supervisee and is assigned hierarchy one. Alice has one supervisee, Julie, at hierarchy one, so she is assigned hierarchy two. Bob, therefore, is assigned at hierarchy three because the next highest level supervisee he has is Alice at hierarchy two. Supplementary Figure 6 presents the network graph for organizational hierarchy.

### Full model results

Supplementary Figure 7 summarizes the main hypotheses and results. Supplementary Tables 1-11 presents detailed model results. Supplementary Table 12 presents results from a logistic regression estimating the factors determining informal boundary spanner status.

### Additional supplementary tables and figures

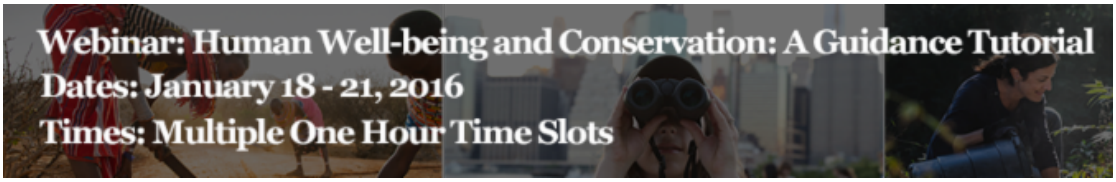
This section includes additional supplementary tables and figures accompanying the analysis. Supplementary Figure 8 shows the timeline of the experiment, showing key activities and data collection events. Supplementary Table 13 investigates the possible factors that could describe the difference between staff survey respondents and non-respondents. Supplementary Table 14

presents differences in observable characteristics for boundary spanner targeting and non-boundary spanner targeting groups. Supplementary Table 15 presents differences on OU-level characteristics between OUs included in and excluded from the experiment.

# Supplementary Figures

**Subject:** Attention: Human Well-being and Conservation Guidance Tutorial
**Date:** Wednesday, January 13, 2016 8:02:44 AM Eastern Standard Time
**From:** Yuta Masuda
**To:** Yuta Masuda

**PLEASE LOAD IMAGES TO SEE EMAIL CONTENT AND WEBEX DETAILS**




**Click here or the Registration button below to see available days and times.**

Dear Yuta,

For the past year, Jessica Musengezi, Elena Shishkova, and I have been developing an online tutorial on incorporating human well-being into conservation strategies. Jessica and I are Social Scientists at the Office of the Chief Scientist, and Elena Shishkova runs the Measures Community of Practice. We are excited to announce that we are now in the pilot testing phase and are ready to start sharing the tutorial.

We are inviting you to participate in pilot testing the Human Well-being and Conservation tutorial based on your background and experiences at the Conservancy. We believe you will provide unique insights to make the tutorial suit the needs of staff throughout the Conservancy. Your participation will help us achieve our vision of having larger conservation impacts for people and nature by helping us refine the tutorial before releasing it to the rest of the Conservancy.

As a participant, you will be able to:

- Participate in a WebEx explaining the motivations of the tutorial, how it fits within the Conversation by Design guidance, and the key topics and components of the online tutorial.
- Have the opportunity to explore the online tutorial (contingent on WebEx attendance), which covers topics such as dimensions of human well-being, incorporating human well-being in results chains, human well-being measures, monitoring and evaluation designs, and other topics.
- Provide open-ended feedback about the tutorial via an optional short survey.

Click Here To Register

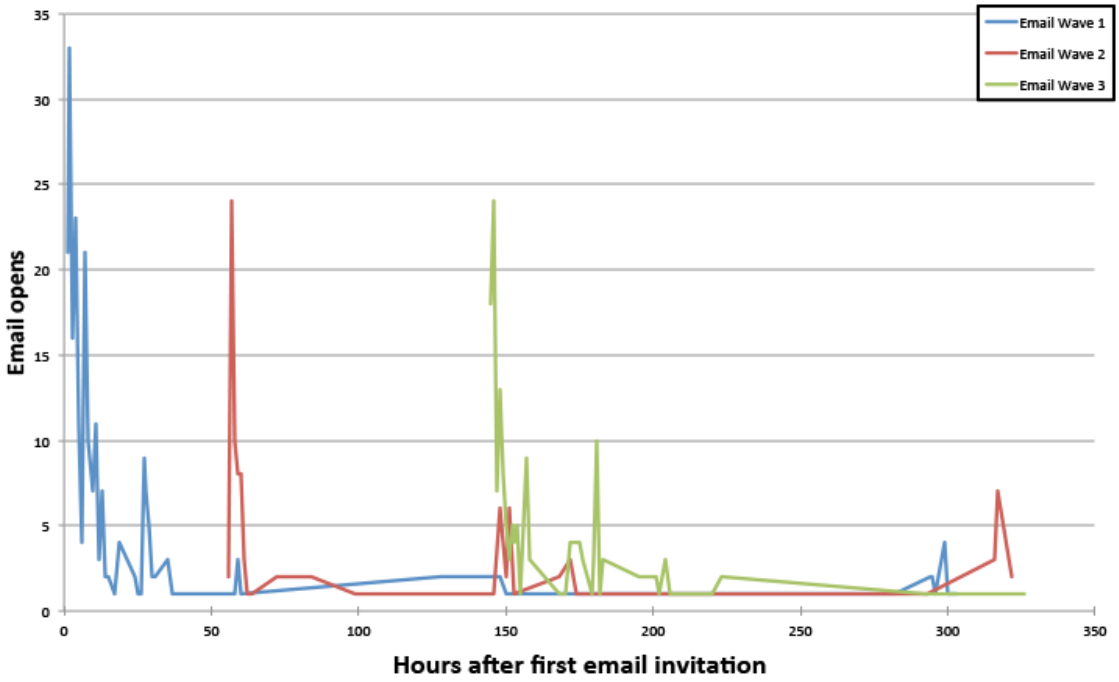
**We are capping participation for the targeted feedback process, so please register here if you are interested in learning and providing feedback about the human well-being tutorials.**

We would like to encourage you to spread the word by forwarding this email to staff within your operating unit.

We hope that you participate in this process and look forward to the unique insights you can provide!

Yuta Masuda
Jessica Musengezi
Elena Shishkova

**Supplementary Figure 1.** Invitation email for the online tutorial.




**Supplementary Figure 2.** Email opens across time by email wave

Dear [RECIPIENT],

Thank you for enrolling in the ***Incorporating Human Well-being into Conservation*** curriculum.

This online, self-paced curriculum consists of 8 online lessons that expose you to the 8 human well-being focal areas; explore the relationship between human well-being components and conservation strategies and indicators; and help you systematically choose monitoring and evaluation methods.

**Launching the training**

- Please log into Learn@tnc (https://learn.tnc.org), click the **My Learning** tab and then click **Current Enrollments** to see a list of all the courses you are currently enrolled in.
- Click on the curriculum title (*Incorporating Human Well-being into Conservation)* to launch the Knowledge Center.
- Once in the Knowledge Center, click **Launch** to launch each lesson.

**We recommend exploring the CbD Beta Guidance document while taking the online tutorial. You can download the CbD Beta Guidance document here.**

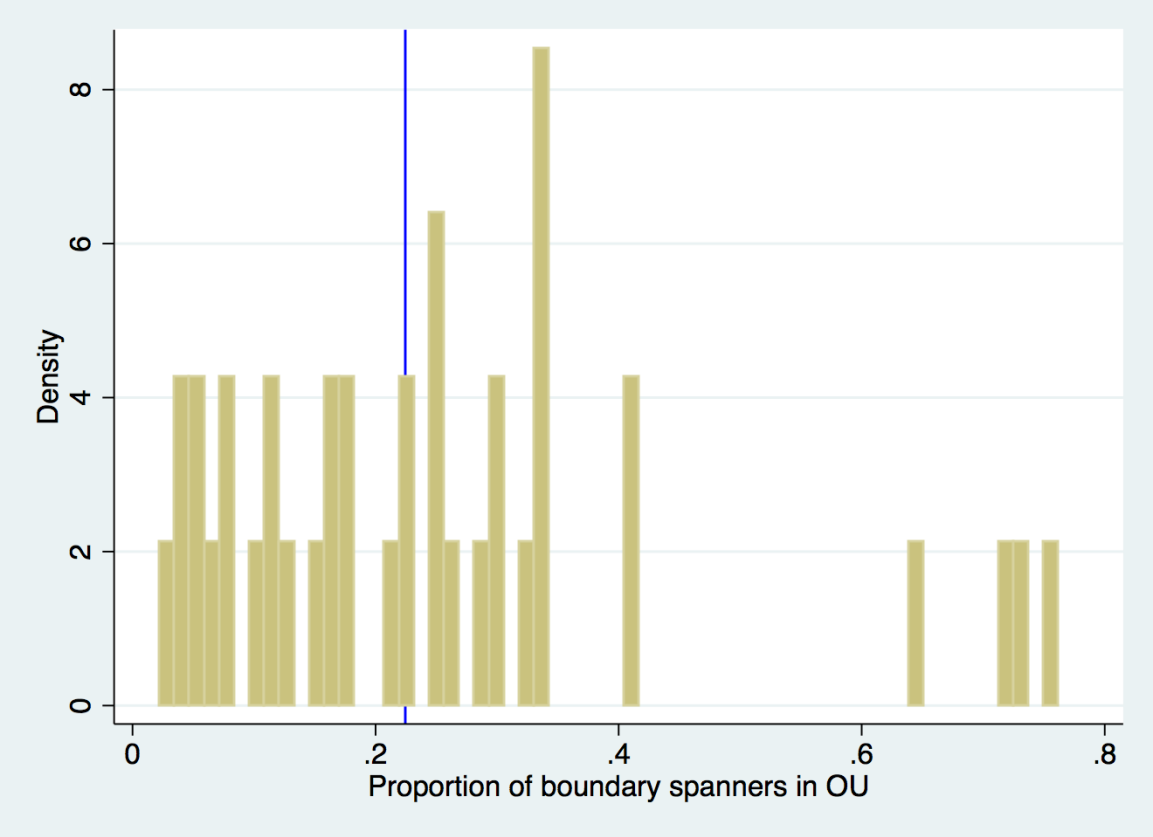
Please note, after you have completed a lesson, the Knowledge Center page does not automatically refresh showing your completed status. Please refresh your screen to see your lesson completion status. Once you have completed all the lessons, the course will be marked as complete and will move from the Current Enrollments page to the Records/Transcripts page.

- Click **My Learning** and then click **Records/Transcripts** to see this in your completed courses.

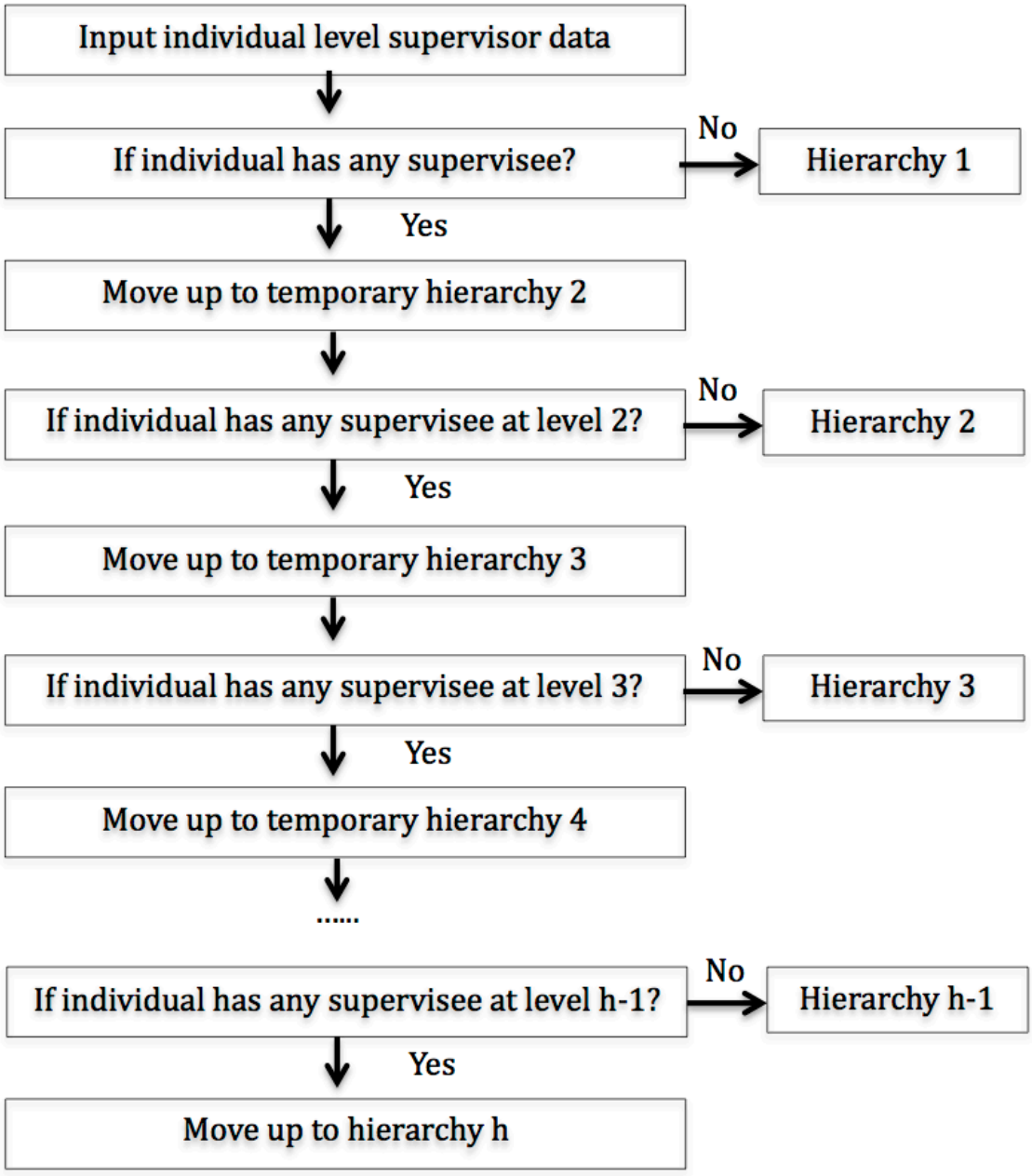
If you need technical assistance with the training, please contact: gsilvertand@tnc.org.

Thank you,
Your learning partners at Learn@tnc

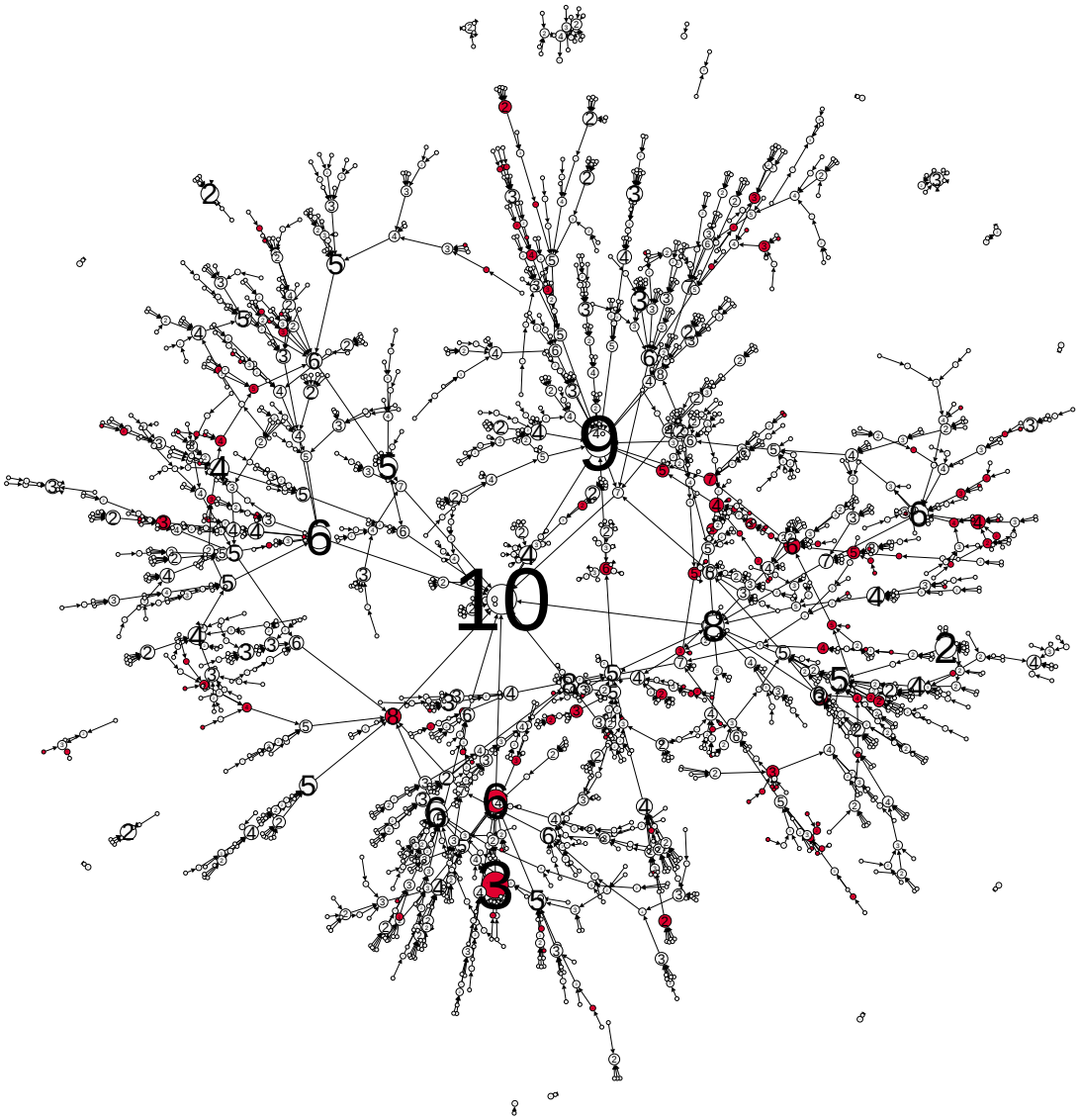
**Supplementary Figure 3.** Enrolment confirmation email for online tutorial.



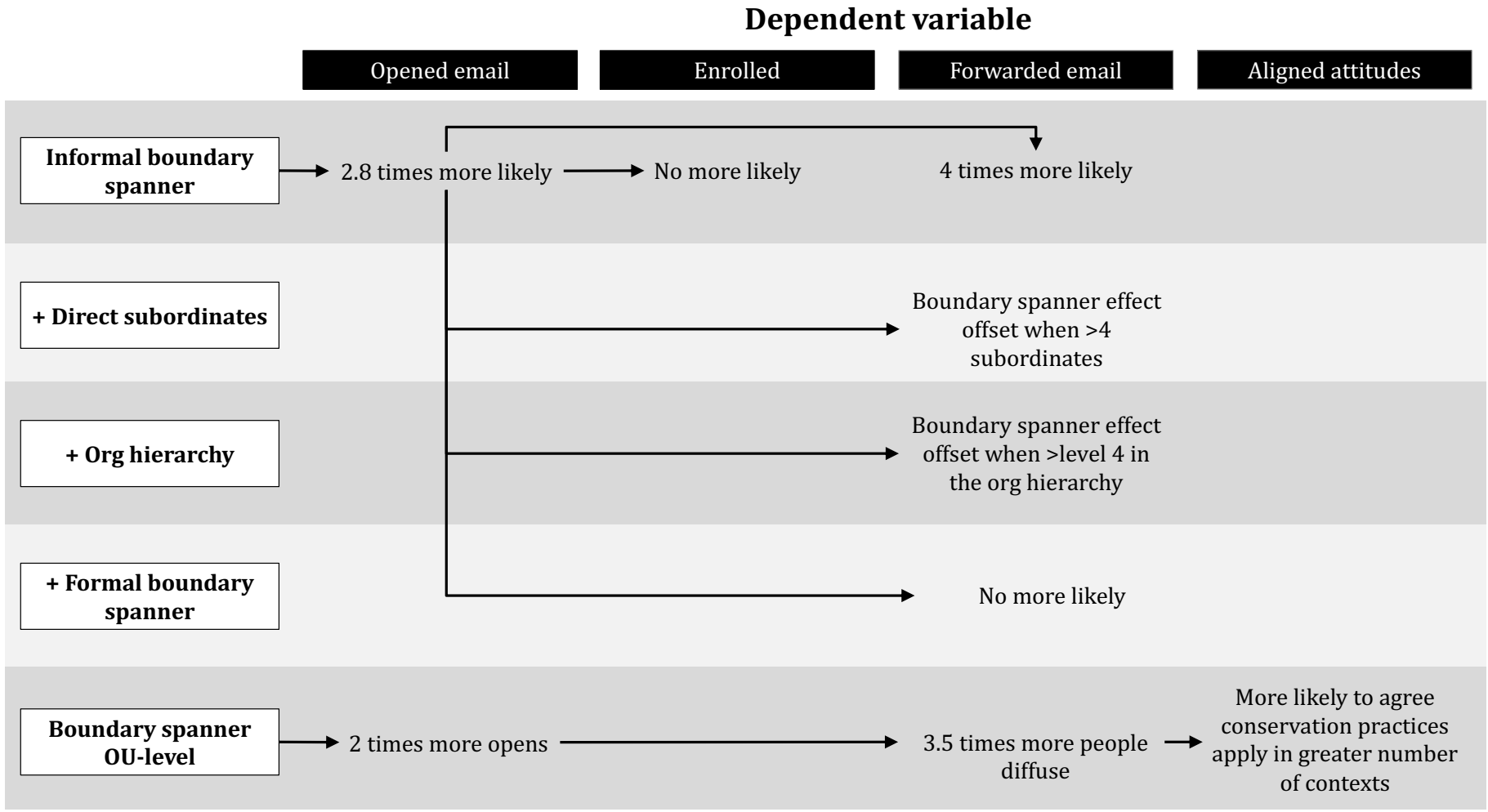

**Supplementary Figure 4.** Histogram for the proportion of boundary spanners in an OU



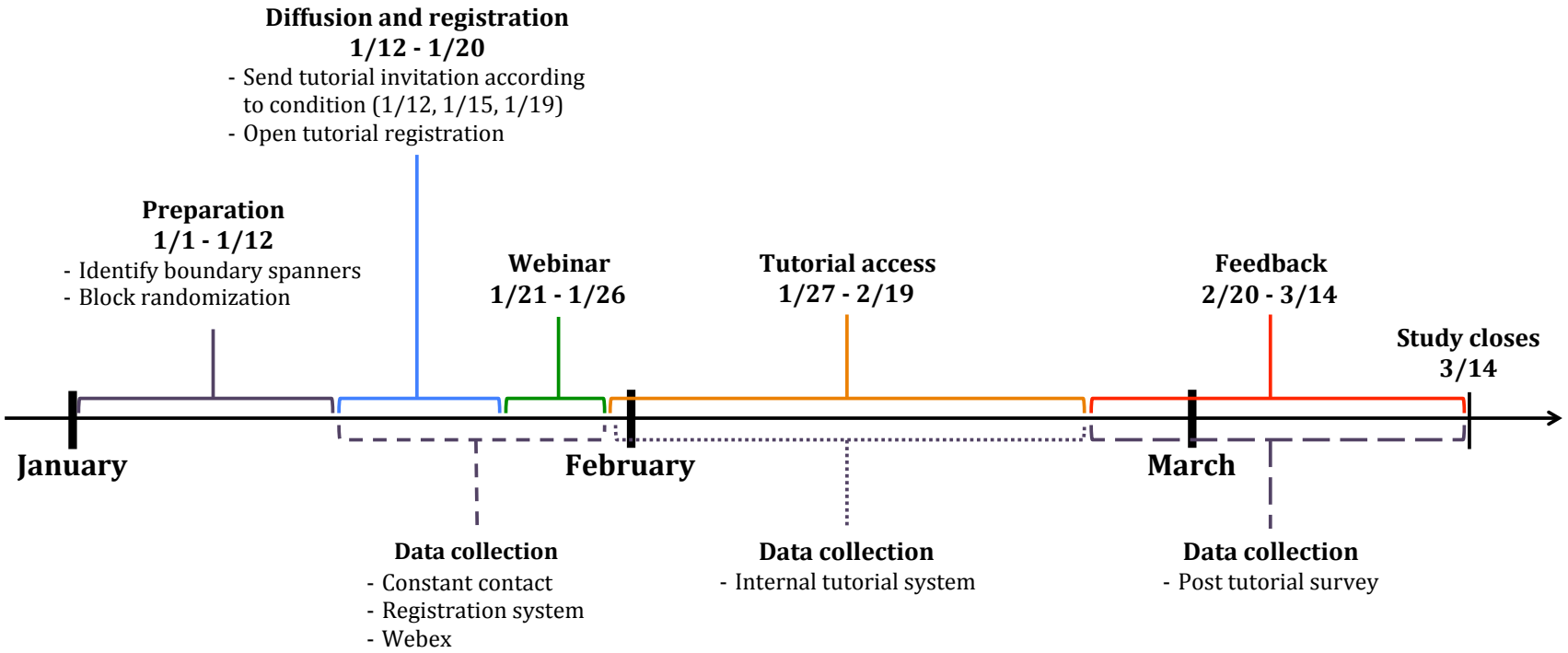

**Supplementary Figure 5.** Steps for identifying organizational hierarchy from supervisory data



**Supplementary Figure 6.** Network graph of organizational hierarchy. Higher numbers indicate higher organizational hierarchy.




**Supplementary Figure 7.** Flowchart of hypotheses and results. Results for individual-level outcomes are estimated via generalized linear mixed models with a logit link function, while OU-level outcomes are estimated via generalized linear models with a log link function. For the Aligned Attitudes dependent variable, we present one of 18 tested attitudes and behaviours. See Supplementary Table 11 for full model results.




**Supplementary Figure 8.** Study timeline starting from January – March 2016. Administrative to identify internal boundary spanners pulled for July 4, 2014 to May 22, 2015.

## Supplementary tables

**Supplementary Table 1.** Cross-tabulation of people opening HWB tutorial invitation email and boundary spanner (n=186)[a]

| | **Informal boundary spanner** | |
|---|---|---|
| | No | Yes |
| No | 62 | 39 |
| Yes | 31 | 54 |

**Supplementary Table 2.** Summary of multilevel logistic regression analysis of opening HWB tutorial invitation email (n=186)

| | B | SE B | Odds Ratio ($e^B$) |
|---|---|---|---|
| Intercept | -0.97* | 0.39 | - |
| *OU-level predictor* | | | |
| Treatment | 1.02** | 0.33 | 2.76 |
| Block | 0.33 | 0.36 | 1.39 |
| Likelihood ratio | $\chi^2$=7.93, *df*=2, *p* = 0.02 | | |

*** p<0.001, ** p<0.01, * p<0.05, + p<0.10

[a] We have 186 staff nested in 26 OUs. Level-2 predictor treatment estimates the boundary spanner effect.

**Supplementary Table 3.** Cross-tabulation of people forwarding HWB tutorial invitation email and boundary spanner (n=186)

| | **Boundary spanner** | |
|---|---|---|
| | No | Yes |
| No | 81 | 56 |
| Yes | 12 | 37 |

**Supplementary Table 4.** Summary of multilevel logistic regression analysis of forwarding HWB tutorial invitation email (n=186)[a]

| | B | SE B | Odds Ratio ($e^B$) |
|---|---|---|---|
| Intercept | -1.91*** | 0.49 | - |
| *OU-level predictor* | | | |
| Treatment | 1.40** | 0.41 | 4.04 |
| Block | 0.003 | 0.42 | 1.00 |
| Likelihood ratio | $\chi^2$=9.22, *df*=2, $p < 0.01$ | | |

*** p<0.001, ** p<0.01, * p<0.05, + p<0.10

[a] We have 186 staff nested in 26 OUs. Level-2 predictor treatment estimates the boundary spanner effect.

**Supplementary Table 5.** Summary of multilevel logistic regression analysis of enrolment in the HWB tutorial (n=178)[a]

| | B | SE B | Odds Ratio ($e^B$) |
|---|---|---|---|
| Intercept | -1.25+ | 0.64 | - |
| *OU-level predictor* | | | |
| Treatment | 0.18 | 0.59 | 1.20 |
| Block | -0.35 | 0.60 | 0.71 |
| Likelihood ratio | $\chi^2$=0.54, *df*=2, $p$= 0.76 | | |

*** p<0.001, ** p<0.01, * p<0.05, + p<0.10

[a] We constrain the sample to be original recipients of the invitation email, see if they enrolled in HWB tutorial email. We have 178 staff nested in 26 OUs. Level-2 predictor treatment estimates the boundary spanner effect.

**Supplementary Table 6.** Summary of negative binomial regression analysis for the number of people opening emails at OU-level (n=26)

| | B | SE B | Odds Ratio ($e^B$) |
|---|---|---|---|
| Treatment | 0.68* | 0.34 | 1.97 |
| OU size | 0.02** | 0.01 | 1.02 |
| Intercept | 0.06 | 0.38 | - |
| Dispersion | 0.36 | 0.20 | - |
| Likelihood ratio | $\chi^2$=9.21, *df*=2, $p < 0.01$ | | |

*** p<0.001, ** p<0.01, * p<0.05, + p<0.10

**Supplementary Table 7.** Summary of negative binomial regression analysis for the number of people engaged in forwarding emails at OU-level (n=26)

| | B | SE B | Odds Ratio ($e^B$) |
|---|---|---|---|
| Treatment | 1.26** | 0.44 | 3.53 |
| OU size | 0.02** | 0.01 | 1.02 |
| Intercept | -1.02 | 0.52 | - |
| Dispersion | 0.39 | 0.27 | - |
| Likelihood ratio | $\chi^2$=11.84, *df*=2, $p < 0.01$ | | |

*** p<0.001, ** p<0.01, * p<0.05, + p<0.10

**Supplementary Table 8.** Summary of multilevel logistic regression analysis for people's diffusion behaviour with predictor number of direct staff[a]

| | Model 1 *(n=161)* | | | Model 2 *(n=161)* | | |
|---|---|---|---|---|---|---|
| | B | SE B | Odds Ratio ($e^B$) | B | SE B | Odds Ratio ($e^B$) |
| Intercept | -1.54* | 0.60 | - | -2.40** | 0.76 | - |
| *Staff-level predictor* | | | | | | |
| Number of direct subordinates | 0.32* | 0.16 | 1.38 | 0.71** | 0.22 | 2.04 |
| Hierarchy | -0.35 | 0.25 | 0.71 | -0.40+ | 0.23 | 0.67 |
| *OU-level predictor* | | | | | | |
| Treatment | 1.20* | 0.46 | 3.32 | 2.27** | 0.67 | 9.70 |
| Block | 0.01 | 0.48 | 1.00 | 0.16 | 0.50 | 1.17 |
| *Cross level interaction* | | | | | | |
| Treatment x Number of direct subordinates | - | - | - | -0.52** | 0.20 | 0.59 |
| Likelihood ratio | $\chi^2$=76.70, *df*=4, $p < .001$ | | | $\chi^2$=84.07, *df*=5, $p < .001$ | | |

*** p<0.001, ** p<0.01, * p<0.05, + p<0.10

[a] Model 1 and 2 have the binary dependent variable if people forwarded invitation email or not. We have 164 staff nested in 26 OUs. Level-2 predictor treatment estimates the boundary spanner effect.

**Supplementary Table 9.** Summary of multilevel logistic analysis for people's diffusion behaviour with predictor organizational hierarchy[a]

| | Model 1 *(n=161)* | | | Model 2 *(n=161)* | | |
|---|---|---|---|---|---|---|
| | B | SE B | Odds Ratio ($e^B$) | B | SE B | Odds Ratio ($e^B$) |
| Intercept | -1.77** | 0.56 | - | -2.89*** | 0.79 | - |
| *Staff-level predictor* | | | | | | |
| Hierarchy | 0.06 | 0.13 | 1.07 | 0.50* | 0.22 | 1.64 |
| *OU-level predictor* | | | | | | |
| Treatment | 1.16* | 0.42 | 3.17 | 2.70** | 0.79 | 14.94 |
| Block | -0.06 | 0.44 | 0.95 | 0.11 | 0.47 | 1.11 |
| *Cross level interaction* | | | | | | |
| Treatment x hierarchy | - | - | - | -0.69* | 0.28 | 0.50 |
| Likelihood ratio | $\chi^2$=71.68, *df*=3, $p < .001$ | | | $\chi^2$=78.04, *df*=4, $p < .001$ | | |

*** p<0.001, ** p<0.01, * p<0.05, + p<0.10

[a] Model 1 and 2 have the binary dependent variable if people forwarded invitation email or not. We have 164 staff nested in 25 OUs. Level-2 predictor treatment estimates the boundary spanner effect.

**Supplementary Table 10.** Summary of multilevel logistic regression analysis for people's diffusion behaviour with predictor formal boundary spanner role[a]

| | Model 1 *(n=161)* | | | Model 2 *(n=161)* | | |
|---|---|---|---|---|---|---|
| | B | SE B | Odds Ratio ($e^B$) | B | SE B | Odds Ratio ($e^B$) |
| Intercept | -2.09*** | 0.52 | - | -2.47*** | 0.62 | - |
| *Staff-level predictor* | | | | | | |
| Formal boundary spanner | 0.46 | 0.37 | 1.58 | 1.20+ | 0.64 | 3.33 |
| *OU-level predictor* | | | | | | |
| Treatment | 1.43** | 0.42 | 4.19 | 1.91** | 0.56 | 6.77 |
| Block | 0.01 | 0.42 | 1.01 | 0.04 | 0.43 | 1.05 |
| *Cross level interaction* | | | | | | |
| Treatment x formal boundary spanner | - | - | - | -1.14 | 0.80 | 0.32 |
| Likelihood ratio | $\chi^2$=10.73, *df*=3, *p*=0.01 | | | $\chi^2$=12.83, *df*=4, *p*=0.01 | | |

*** p<0.001, ** p<0.01, * p<0.05, + p<0.10

[a] Model 1 and 2 have the binary dependent variable if people forwarded invitation email or not. We have 164 staff nested in 25 OUs. Level-2 predictor treatment estimates the boundary spanner effect.

**Supplementary Table 11.** Summary of treatment effects in linear mixed effect regression analysis for people's changes in attitudes and practices

| | | Treatment effect | |
|---|---|---|---|
| Changes in practice outcomes | n | B | SE B |
| 1. Engagement in CbD 2.0 evidence based practices[a] | 234 | 0.01 | 0.03 |
| 2. Engagement in CbD 2.0 people in conservation practices[a] | 234 | 0.02 | 0.04 |
| 3. Incorporate evidence in the conservation planning process[b] | 98 | -0.45 | 0.55 |
| 4. Incorporate uncertainty in the conservation planning process[b] | 123 | -0.54 | 0.46 |
| 5. Use Human Subjects SOP[b] | 220 | 0.31 | 0.33 |
| 6. Measure our impacts on people[b] | 230 | 0.08 | 0.39 |
| 7. Use standards of measurement (e.g., SMART) for monitoring and evaluating our impacts on people[b] | 224 | 0.12 | 0.38 |
| 8. How has your OU diversified the number of funding sources in the past 12 months[a] | 182 | -0.10 | 0.09 |
| 9. How many external partners (e.g., agencies or organizations) have you worked with in the past 12 months[c] | 419 | 0.14 | 0.10 |
| 10. How much have you shared CbD 2.0 knowledge or guidance with outside collaborators[a] | 420 | 0.02 | 0.10 |
| 11. Your outside collaborators engage in practices consistent with CbD 2.0[a] | 348 | -0.08 | 0.07 |
| 12. Applying the CbD 2.0 approach has increased the types of activities we do that can be funded[a] | 325 | 0.14 | 0.06 |
| 13. Applying the CbD 2.0 approach has increased the number of partners we can work with outside of TNC[a] | 325 | 0.16$^{+}$ | 0.05 |
| 14. Applying the CbD 2.0 approach has increased the number of constituents we serve[a] | 327 | 0.17 | 0.08 |
| 15. Applying the CbD 2.0 approach has increased the expertise we have access to[a] | 318 | 0.09 | 0.08 |
| 16. Applying the CbD 2.0 approach has increased our funding sources[a] | 306 | 0.05 | 0.07 |
| 17. Applying the CbD 2.0 approach has increased the number of contexts in which we can work[a] | 317 | 0.22* | 0.06 |
| 18. Downloaded the CbD 2.0 Guidance document, released on March 2016[b] | 419 | -0.32 | 0.30 |

*** $p<0.00006$ [d], ** $p<0.0006$ [d] , * $p<0.0027$ [d], + $p<0.006$ [d]

[a] Outcomes are continuous variables, following a normal distribution

[b] Outcomes are binary variables, following a Bernoulli distribution

[c] Outcomes are count variables, following a Poisson distribution

[d] Significance test p-value is adjusted based on Bonferroni adjustment, penalizing multiple statistical tests on 18 changes in practice outcomes.

[e] Sample size reported is the sample size at the individual-level. Treatment effects are estimated at OU-level. Individuals nested in 25 OUs, and we are estimating the OU-level treatment effect on individual's change in practices.

**Supplementary Table 12.** Summary of logistic regression analysis for whether people are an informal boundary spanner (n=848)[a]

| | B | SE B | Odds Ratio ($e^B$) |
|---|---|---|---|
| Job grade | 0.00 | 0.05 | 1.00 |
| Job family (Executive) | 0.09 | 0.27 | 1.09 |
| Job family (Scientist) | 0.18 | 0.19 | 1.20 |
| Service years | 0.01 | 0.01 | 1.01 |
| Hierarchy | -0.06 | 0.11 | 0.94 |
| Direct reports | 0.03 | 0.07 | 1.03 |
| Intercept | -0.92* | 0.37 | |
| Likelihood ratio | $\chi^2$=7.05, *df*=6, *p*= 0.32 | | |

*** p<0.001, ** p<0.01, * p<0.05, + p<0.10

[a] The reference group is people whose job family is conservationist. In the sample, we have 247 informal boundary spanners, and 691 non-boundary spanners.

**Supplementary Table 13.** Summary of logistic regression analysis of responding to the staff survey (n=951)

| | B | SE B | Odds Ratio ($e^B$) |
|---|---|---|---|
| Service Years | 0.01 | 0.01 | 1.01 |
| Job grade | 0.34*** | 0.04 | 1.40 |
| Job family (Executive) | -0.49 | 0.39 | 0.61 |
| Job family (Scientist) | 0.22 | 0.21 | 1.25 |
| Intercept | -2.54*** | 0.34 | 0.08 |
| Likelihood ratio test | | | |
| OUs fixed effect | $\chi^2$=53.56, *df*=25, *p*<0.001 | | |
| Full model | $\chi^2$=159.42, *df*=29, *p*<0.001 | | |

*** p<0.001, ** p<0.01, * p<0.05, + p<0.10

[a] In the sample, we have 437 respondents and 514 non-respondents. The reference group is people whose job family is in "conservation" and are in OU 34629. We use 25 dummy variables for 26 OUs to estimate the relationship of being in different OUs on the survey response rate and found that different OUs have a different proportion of people responding to the email, which is significant at p<0.01.

**Supplementary Table 14.** Descriptive statistics

| | Treatment (1) | | Control (2) | | (3) |
|---|---|---|---|---|---|
| **Original email recipient variables** | **Mean** | **SD** | **Mean** | **SD** | **Diff** |
| Service years | 9.8 | 0.70 | 10 | 0.80 | -0.2 |
| Job grade | 6.1 | 0.21 | 6.4 | 0.21 | -0.32 |
| Executive (%) | 8.2 | 2.8 | 1.2 | 1.2 | 7.1* |
| Conservation (%) | 76 | 4.3 | 79 | 4.2 | -3.1 |
| Science (%) | 15 | 3.7 | 19 | 4.1 | -4.1 |
| Community of practice count | 0.34 | 0.06 | 0.47 | 0.7 | -0.14 |
| Senior leader (%) | 6.2 | 2.4 | 4.3 | 2.1 | 1.8 |
| Direct reports | 1.5 | 0.24 | 1.0 | 0.18 | 0.51+ |
| Online training courses | 21 | 0.93 | 20 | 0.67 | 1.0 |
| **Operating unit variables** | | | | | |
| Female (%) | 56 | 1.8 | 55 | 1.8 | 0.77 |
| Service years | 8.3 | 0.28 | 8.3 | 0.25 | 0.10 |
| Boundary spanners (%) | 25 | 4.9 | 21 | 3.5 | 4.9 |
| Operating unit size | 31 | 4.9 | 32 | 7.1 | -1.2 |
| Number of projects | 44 | 6.5 | 47 | 9.8 | -2.8 |
| **Diffusion variables** | | | | | |
| Total email opens | 4.1 | 0.66 | 2.9 | 1.2 | 3.5 |
| Forwarded email (%) | 38 | 5.0 | 13 | 3.5 | 26*** |
| Registration | 27 | 4.6 | 21 | 4.2 | 7.1 |
| *n* (Original email recipient) | 96 | | 82 | | 178 |
| *n* (Operating units) | 13 | | 13 | | 26 |
| *n* (Total staff) | 723 | | 764 | | 1,487 |

*** p<0.001, ** p<0.01, * p<0.05, + p<0.10

**Supplementary Table 15.** Descriptive statistics on the difference between operating units included in the experiment and operating units excluded from the experiment

| | Included OUs (1) | | Excluded OUs (2) | | (3) |
|---|---|---|---|---|---|
| **Operating unit variables** | **Mean** | **SD** | **Mean** | **SD** | **Diff** |
| Service years | 9.89 | 2.31 | 11.05 | 3.51 | -1.16 |
| Job grade | 6.04 | 0.90 | 6.66 | 1.11 | -0.62+ |
| Organizational Hierarchy | 1.90 | 0.24 | 2.20 | 0.70 | -0.30 |
| Direct reports | 1.28 | 0.32 | 1.67 | 0.91 | -0.39 |
| Conservation (%) | 0.79 | 0.11 | 0.85 | 0.08 | -0.06* |
| Science (%) | 0.15 | 0.11 | 0.04 | 0.06 | 0.11*** |
| Executive (%) | 0.07 | 0.03 | 0.11 | 0.06 | -0.04* |
| Operating unit size | 31.58 | 21.57 | 10.81 | 5.74 | 20.76*** |
| *n* (Operating units) | 26 | | 16 | | 42 |
| *n* (Total staff) | 821 | | 173 | | 994 |

*** p<0.001, ** p<0.01, * p<0.05, + p<0.10