Appendix S2

*Amphibian species data.—* To perform a species-specific analysis, we used the data from the four most abundant amphibians (*Espadarana prosoblepon, Pristimantis cerasinus, Pristimantis cruentus, Sachatamia albomaculata*), comprising 80% of the capture data (Table S1).

*Species-specific model.—* We used the same modeling framework as presented in the main text, but we indexed latent state variables and parameters by species identity *h*. This allowed us to obtain species species-specific parameter estimates. To aid in model convergence, we assumed that the four species of interested shared the parameter estimates: recovery (r), transmission intercept (α0), transmission slope (α1), indicator variable (q), infected and uninfected host detection probability during the wet and dry seasons (θ0s, θ1s), and detection slope estimates for the number of observers (θ2) and infection intensity (θ3). We ran three chains for each parameter and ran each chain for 200,000 iterations, with a burn-in period of 20,000 iterations, and thinned by 200. All other model specifications and evaluating converge criteria were the same between the pooled model and the species-specific model.

*Results.—* Amphibian species abundance was either stable or increase from 2010 to 2014 (Fig. S1). *Bd* prevalence varied by species and was consistently between 61-99% from wet 2011 to dry 2014 (Fig. S1); but, *Bd* prevalence was difficult to estimate for some species wet 2010. Mean *Bd* infection intensity by species was consistently low.

The model did well in estimating the expected number of individuals gained per site across all species (i.e., narrow credible intervals; Table S2), and the model estimated high survival probability of infected and uninfected hosts when the sample size was large enough (4 out of 8 parameters identified; i.e., infected and uninfected *Espadarana prosoblepon,* infected *Pristimantis cerasinus*, infected *Sachatamia albomaculata*). The large credible intervals for the remaining survival probabilities are likely caused by insufficient data (i.e., uninfected *Pristimantis cerasinus*, uninfected *Sachatamia albomaculata*, uninfected and infected *Pristimantis cruentus*).



Figure S1. Seasonal fluctuations in amphibian species and *Bd* abundance from 2010 to 2014 in El Copé, Panama. (A) Amphibian abundance, (B) pathogen prevalence, and (C) host infection intensity over time by species. In panels A and B, point ranges represent 95% credible intervals around the mean values (points). In panel C, each point represent an individual capture that season.

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Figure S2. (A) Apparent monthly survival probability of uninfected and infected hosts; and (B) expected number of infected and uninfected hosts gained per site between seasons (shown for the average of 8.5 months). Ranges represent 95% credible intervals around the mean values (points).

Table S1. Summary of amphibian captures with the number of samples collected, mean *Bd* zoospore load, standard error (SE) of *Bd* load, and pathogen prevalence for each species. The majority of samples were collected from four species of two families highlighted in bold.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Family | Genus | Species | Percent decline\* | No. of swabs | Mean *Bd* load | SE *Bd* load | *Bd* prevalence |
| Hylidae | *Agalychnis* | *callidryas* | 0 | 1 | 0.00 | 0.00 | 0.00 |
| Plethodontidae | *Bolitaglossa* | *schizodactyla* | -16.49 | 15 | 99.66 | 94.18 | 0.27 |
| Bufonidae | *Chaunus* | *marinus* | 0 | 5 | 0.00 | 0.00 | 0.00 |
| Centrolenidae | *Cochorenella* | *eukenemos* | -100 | 6 | 0.12 | 0.12 | 0.17 |
| Centrolenidae | *Cochranella* | *granulosa* | -100 | 0 | 0.00 | 0.00 | 0.00 |
| Dendrobatidae | *Colostethus* | *flotator* | -36.79 | 1 | 0.00 | 0.00 | 0.00 |
| Dendrobatidae | *Colostethus* | *nubicola* | -100 | 2 | 0.00 | 0.00 | 0.00 |
| Craugastoridae | *Craugastor* | *bransfordi* | -96.29 | 1 | 0.00 | 0.00 | 0.00 |
| Craugastoridae | *Craugastor* | *crassidigitus* | -92.90 | 25 | 90.27 | 85.01 | 0.16 |
| Craugastoridae | *Craugastor* | *fitzingeri* | 132.26 | 10 | 3.70 | 3.34 | 0.40 |
| Eleutherodactylidae | *Diasporus* | *“orange”* | NA | 46 | 63.40 | 41.37 | 0.24 |
| Eleutherodactylidae | *Diasporus* | *“peep"* | NA | 18 | 12.95 | 8.85 | 0.22 |
| Eleutherodactylidae | *Diasporus* | *“tock”* | NA | 9 | 1.63 | 1.49 | 0.33 |
| **Centrolenidae** | ***Espadarana*** | ***prosblepon*** | -1.53 | **770** | **10.46** | **4.06** | **0.20** |
| Centrolenidae | *Hyalinobatrachium* | *colymbiphyllum* | -48.02 | 30 | 14.26 | 9.86 | 0.13 |
| Centrolenidae | *Hyalinobatrachium* | *vireovittatum* | NA | 2 | 41.92 | 40.86 | 1.00 |
| Hylidae | *Hyloscurtis* | *colymba* | -91.76 | 3 | 555.75 | 552.99 | 1.00 |
| Hylidae | *Hyloscurtis* | *palmeri* | -25.35 | 15 | 61.50 | 59.11 | 0.40 |
| Ranidae | *Lithobates* | *warszewitchii* | -100 | 1 | 6.35 | 0.00 | 1.00 |
| Strabomantidae | *Pristimantis* | *caryophyllaceus* | 140.94 | 6 | 4.20 | 3.02 | 0.33 |
| **Strabomantidae** | ***Pristimantis*** | ***cerasinus*** | -53.15 | **213** | **48.41** | **28.22** | **0.31** |
| **Strabomantidae** | ***Pristimantis*** | ***cruentus*** | -34.27 | **190** | **166.32** | **110.76** | **0.29** |
| Strabomantidae | *Pristimantis* | *educatoris* | NA | 1 | 0.00 | 0.00 | 0.00 |
| Strabomantidae | *Pristimantis* | *museosus* | 9.85 | 11 | 706.31 | 505.44 | 0.45 |
| Strabomantidae | *Pristimantis* | *pardalis* | 116.36 | 45 | 1.55 | 0.79 | 0.29 |
| Strabomantidae | *Pristimantis* | *ridens* | -100 | 7 | 0.49 | 0.37 | 0.29 |
| Craugastoridae | *Craugastor* | *talamancae* | 80.62 | 1 | 0.00 | 0.00 | 0.00 |
| Bufonidae | *Rhaebo* | *haematiticus* | -90.17 | 9 | 0.45 | 0.43 | 0.33 |
| **Centrolenidae** | ***Sachatamia*** | ***albomaculata*** | -92.71 | **155** | **79.61** | **56.77** | **0.29** |
| Centrolenidae | *Sachatamia* | *ilex* | 108.30 | 16 | 0.16 | 0.13 | 0.13 |
| Hylidae | *Smilisca* | *phaeota* | 125.11 | 1 | 0.00 | 0.00 | 0.00 |
| Hylidae | *Smilisca* | *silia* | -100 | 6 | 0.00 | 0.00 | 0.00 |
|  |  |  |  |  |  |  |  |
|  |  | Total |  | 1621 | 61.55 | 50.22 | 0.26 |

\* Values are obtained from Crawford et al. 2010

Table S2. Summary of parameter outputs for species-by-species stage-structured *N*-mixture model. See methods for parameter definitions. All model parameter values consist of mean and 95% credible interval. Parameter estimates are on the logit scale, except recruitment on the log scale.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Disease class | Parameter name | Symbol | Species | Mean | 95% credible interval | |
| Uninfected | Survival | Φ1 | *E. prosoblepon* | 4.14 | 3.08 | 5.32 |
| Uninfected | Survival | Φ1 | *P. cerasinus* | 0.58 | -2.41 | 3.28 |
| Uninfected | Survival | Φ1 | *P. cruentus* | -0.54 | -3.07 | 1.91 |
| Uninfected | Survival | Φ1 | *S. albomaculata* | -0.27 | -3.09 | 1.99 |
| Infected | Survival | Φ2 | *E. prosoblepon* | 5.94 | 4.77 | 7.30 |
| Infected | Survival | Φ2 | *P. cerasinus* | 3.06 | 2.34 | 3.82 |
| Infected | Survival | Φ2 | *P. cruentus* | 0.63 | -1.94 | 1.97 |
| Infected | Survival | Φ2 | *S. albomaculata* | 3.24 | 2.53 | 3.98 |
| Uninfected | Recruitment intercept | β01 | *E. prosoblepon* | -2.12 | -2.66 | -1.64 |
| Uninfected | Recruitment intercept | β01 | *P. cerasinus* | -2.93 | -3.61 | -2.36 |
| Uninfected | Recruitment intercept | β01 | *P. cruentus* | -3.82 | -4.63 | -3.01 |
| Uninfected | Recruitment intercept | β01 | *S. albomaculata* | -2.80 | -3.44 | -2.22 |
| Infected | Recruitment intercept | β02 | *E. prosoblepon* | -2.23 | -2.97 | -1.58 |
| Infected | Recruitment intercept | β02 | *P. cerasinus* | -1.29 | -1.56 | -1.01 |
| Infected | Recruitment intercept | β02 | *P. cruentus* | -1.08 | -1.47 | -0.71 |
| Infected | Recruitment intercept | β02 | *S. albomaculata* | -2.46 | -3.06 | -1.97 |
|  | Recruitment slope | β1 | *E. prosoblepon* | 0.12 | -0.39 | 0.67 |
|  | Recruitment slope | β1 | *P. cerasinus* | 0.27 | 0.01 | 0.51 |
|  | Recruitment slope | β1 | *P. cruentus* | 0.68 | 0.38 | 1.02 |
|  | Recruitment slope | β1 | *S. albomaculata* | -0.09 | -0.50 | 0.33 |
|  | Recovery | r | All | -1.22 | -3.45 | 0.48 |
|  | Transmission intercept | α0 | All | 0.20 | -3.18 | 2.85 |
|  | Transmission slope | α1 | All | -1.62 | -4.50 | 2.01 |
|  | Indicator variable | q | All | 0.30 | 0.00 | 1.00 |
| Uninfected | Dry season | θ01 | All | -2.51 | -2.89 | -2.14 |
| Uninfected | Wet season | θ11 | All | -3.12 | -3.56 | -2.70 |
| Infected | Dry season | θ02 | All | -2.09 | -2.41 | -1.79 |
| Infected | Wet season | θ12 | All | -2.44 | -2.74 | -2.16 |
|  | Detection slope:  No. of observers | θ2 | All | 0.24 | 0.14 | 0.32 |
|  | Detection slope: Infection intensity | θ3 | All | 0.05 | 0.02 | 0.09 |

References

Crawford, A. J., Lips, K. R., & Bermingham, E. (2010). Epidemic disease decimates amphibian abundance, species diversity, and evolutionary history in the highlands of central Panama. *Proceedings of the National Academy of Sciences of the United States of America*, 107, 13777–82.