**Supplementary Material**

Evaluating abundance and trends in a Hawaiian avian community using state-space analysis

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Table S1. Sampling effort at Hakalau in open and closed forest strata by year. Effort is the number of samples conducted at the forest bird survey stations. Missing year in the series indicated with a NA.

|  |  |  |
| --- | --- | --- |
| Year | Open | Closed |
| 1987 | 205 | NA |
| 1988 | 213 | NA |
| 1989 | 198 | NA |
| 1990 | 203 | NA |
| 1991 | 197 | NA |
| 1992 | 197 | NA |
| 1993 | 194 | NA |
| 1994 | 194 | NA |
| 1995 | 195 | NA |
| 1996 | 198 | NA |
| 1997 | 193 | NA |
| 1998 | 197 | NA |
| 1999 | 195 | 113 |
| 2000 | 198 | 108 |
| 2001 | 196 | 93 |
| 2002 | 195 | 94 |
| 2003 | 200 | 95 |
| 2004 | 198 | 95 |
| 2005 | 168 | 63 |
| 2006 | 164 | 61 |
| 2007 | 169 | 74 |
| 2008 | 158 | 85 |
| 2009 | NA | NA |
| 2010 | 140 | 59 |
| 2011 | 142 | 62 |
| 2012 | 162 | 63 |

Table S2. The best-fit detection-function model of each species used to calculate population abundances at Hakalau Forest NWR. Detection function and data histogram figures for the best-fit model, and AICc statistics for the full set of detection-function models are provided in Appendix 2. Models included half-normal (HN) and hazard-rate (HR) key detection functions and with cosine (COS), and Hermite polynomial (Hpoly) series expansions. The numbers in parenthesis indicate the series expansion order adjustments. Covariates included detection type (Detect, pooled auditory and visually confirmed auditory detections [14Detect], and pooled visual and visually confirmed auditory detections [24Detect]). Data were truncated at a distance where detection probability was < 10%. This procedure facilitates modeling by deleting outliers and reducing the number of parameters needed to modify the detection function.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Species | Model | Series expansion | Covariate | Truncation (m) |
| Hawai‘i ‘Elepaio | HR | Key | Detect | 54.1 |
| ‘Ōma‘o | HR | Key | 24Detect | 73.7 |
| Hawai‘i ‘Amakihi | HN | Cos(2,3) | 14Detect | 57.0 |
| ‘Akiapōlā‘au | HN | Key | 24Detect | 78.0 |
| Hawai‘i Creeper | HN | Key | 24Detect | 58.0 |
| Hawai‘i ‘Ākepa | HR | Key | 24Detect | 58.0 |
| ‘I‘iwi | HN | Hpoly(4,6) | 14Detect | 49.8 |
| ‘Apapane | HR | Key | Detect | 58.3 |
| Red-billed Leiothrix | HN | Cos(2,3) | 24Detect | 68.0 |
| Japanese White-eye | HN | Key | 24Detect | 45.8 |



 Figure S1. Species-specific detection function (line), and distance data (histogram) pooled across all surveys from 1987 to 2012.

Table S3. Model parameters and model-selection results for forest birds at Hakalau Forest NWR. Within each species analysis, models were sorted by differences in second-order Akaike’s information criterion corrected for small sample size (∆AICc) between each candidate model and the model with the lowest AICc value. Models examined included half-normal (HN) and hazard-rate (HR) key detection functions and with cosine (COS), Hermite polynomial (Hpoly), and simple polynomial (Spoly) series expansions. Covariates were incorporated with the most parsimonious model to improve model precision. Covariates included the categorical variables cloud cover (Cloud), amount of rain (Rain), Beaufort wind scale (Wind), Beaufort gust scale (Gust), detection type (Detect, pooled auditory and visually confirmed auditory detections [14Detect], and pooled visual and visually confirmed auditory detections [24Detect]), vegetation (Veg), observer (OBS), and survey year [Year(f)]. Continuous covariates included the variables elevation, (Elev), time of day (Time), and survey year [Year(c)]. The number of estimated parameters (# Params), and negative log-likelihood (-LogL) are presented. The Akaike model weight (*w*) is the likelihood that each model is the best of the 19 models evaluated for each species.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Species |  |  |  |  |  |  |  |
| Model | Series expansion | Covariate | # Params | -LogL | AICc | ∆AICc | *w* |
| Hawai‘i ‘Elepaio | |  |  |  |  |  |  |
| HR | Key | Detect | 4 | 23763.18 | 47534.38 | 0.00 | 1.00000 |
| HR | Key | 24Detect | 3 | 23791.94 | 47589.89 | 55.51 | 0.00000 |
| HR | Key | 14Detect | 3 | 24117.28 | 48240.56 | 706.18 | 0.00000 |
| HR | Key | Observer | 34 | 24774.08 | 49616.53 | 2082.15 | 0.00000 |
| HR | Cos |  | 3 | 24826.95 | 49659.91 | 2125.53 | 0.00000 |
| HN | Cos |  | 2 | 24830.50 | 49665.00 | 2130.62 | 0.00000 |
| HN | Key |  | 1 | 24840.46 | 49682.92 | 2148.54 | 0.00000 |
| HR | Key |  | 2 | 24869.95 | 49743.89 | 2209.51 | 0.00000 |
| HR | Key | Time | 3 | 24873.36 | 49752.72 | 2218.34 | 0.00000 |
| HR | Key | Elev | 3 | 24873.37 | 49752.75 | 2218.37 | 0.00000 |
| HR | Key | Veg | 4 | 24873.20 | 49754.40 | 2220.02 | 0.00000 |
| HR | Key | Rain | 6 | 24873.08 | 49758.18 | 2223.80 | 0.00000 |
| HR | Key | Gust | 6 | 24873.30 | 49758.61 | 2224.23 | 0.00000 |
| HR | Key | Wind | 6 | 24873.51 | 49759.03 | 2224.65 | 0.00000 |
| HR | Key | Year(f) | 26 | 24855.12 | 49762.46 | 2228.08 | 0.00000 |
| HR | Key | Cloud | 13 | 24872.66 | 49771.39 | 2237.01 | 0.00000 |
| HN | Hpoly1 |  |  |  |  |  |  |
| HR | Spoly2 |  |  |  |  |  |  |
| HR | Key | Year(c) 2 |  |  |  |  |  |
| ‘Ōma‘o |  |  |  |  |  |  |  |
| HR | Key | 24Detect | 2 | 53841.70 | 107687.40 | 0.00 | 0.70057 |
| HR | Key | Detect | 3 | 53841.55 | 107689.10 | 1.70 | 0.29943 |
| HR | Key | 14Detect | 2 | 54337.00 | 108678.00 | 990.60 | 0.00000 |
| HR | Key | Observer | 51 | 54367.45 | 108837.30 | 1149.90 | 0.00000 |
| HR | Key |  | 2 | 54539.50 | 109083.00 | 1395.60 | 0.00000 |
| HR | Key | Year(f) | 25 | 54521.06 | 109092.20 | 1404.80 | 0.00000 |
| HR | Key | Veg | 3 | 54641.43 | 109288.90 | 1601.50 | 0.00000 |
| HR | Key | Wind | 5 | 54641.44 | 109292.90 | 1605.50 | 0.00000 |
| HR | Key | Elev | 2 | 54647.39 | 109298.80 | 1611.40 | 0.00000 |
| HR | Key | Gust | 5 | 54656.30 | 109322.60 | 1635.20 | 0.00000 |
| HR | Key | Rain | 5 | 54658.23 | 109326.50 | 1639.10 | 0.00000 |
| HR | Key | Cloud | 12 | 54657.12 | 109338.30 | 1650.90 | 0.00000 |
| HR | Key | Time | 2 | 54676.24 | 109356.50 | 1669.10 | 0.00000 |
| HN | Key |  | 1 | 54682.33 | 109366.70 | 1679.30 | 0.00000 |
| HN | Cos2 |  |  |  |  |  |  |
| HN | Hpoly2 |  |  |  |  |  |  |
| HR | Cos2 |  |  |  |  |  |  |
| HR | Spoly2 |  |  |  |  |  |  |
| HR | Key | Year(c)2 |  |  |  |  |  |
| Hawai‘i ‘Amakihi | |  |  |  |  |  |  |
| HN | Cos(2,3) | 14Detect | 4 | 98201.18 | 196410.40 | 0.00 | 1.00000 |
| HN | Cos(2,3) | Year(f) | 27 | 99232.88 | 198519.80 | 2109.40 | 0.00000 |
| HN | Cos(2,3) | Veg | 5 | 99427.15 | 198864.30 | 2453.90 | 0.00000 |
| HN | Cos(2,3) | Cloud | 14 | 99438.72 | 198905.50 | 2495.10 | 0.00000 |
| HN | Cos(2,3) | Wind | 7 | 99459.38 | 198932.80 | 2522.40 | 0.00000 |
| HN | Cos(2,3) | Rain | 7 | 99473.70 | 198961.40 | 2551.00 | 0.00000 |
| HN | Cos(2,3) | Elev | 4 | 99505.69 | 199019.40 | 2609.00 | 0.00000 |
| HN | Cos(2,3) | Gust | 7 | 99528.20 | 199070.40 | 2660.00 | 0.00000 |
| HN | Cos(2,3) | Time | 4 | 99537.14 | 199082.30 | 2671.90 | 0.00000 |
| HN | Cos |  | 3 | 99541.65 | 199089.30 | 2678.90 | 0.00000 |
| HR | Spoly |  | 4 | 99547.11 | 199102.20 | 2691.80 | 0.00000 |
| HR | Cos |  | 4 | 99548.44 | 199104.90 | 2694.50 | 0.00000 |
| HN | Key |  | 1 | 99581.30 | 199164.60 | 2754.20 | 0.00000 |
| HR | Key |  | 2 | 99626.63 | 199257.30 | 2846.90 | 0.00000 |
| HN | Hpoly3 |  |  |  |  |  |  |
| HN | Cos(2,3) | Detect3 |  |  |  |  |  |
| HN | Cos(2,3) | 24Detect3 |  |  |  |  |  |
| HN | Cos(2,3) | Observer2 |  |  |  |  |  |
| HN | Cos(2,3) | Year(c) 2 |  |  |  |  |  |
| ‘Akiapōlā‘au | |  |  |  |  |  |  |
| HN | Key | Detect 4 | 3 | 2712.75 | 5431.53 | 0.00 | 0.81382 |
| HN | Key | 24Detect | 2 | 2715.23 | 5434.48 | 2.95 | 0.18618 |
| HN | Key | 14Detect | 2 | 2755.55 | 5515.12 | 83.59 | 0.00000 |
| HN | Key | Observer | 3 | 2775.87 | 5557.78 | 126.25 | 0.00000 |
| HN | Key | Rain | 4 | 2781.53 | 5571.13 | 139.60 | 0.00000 |
| HN | Hpoly |  | 3 | 2786.12 | 5578.28 | 146.75 | 0.00000 |
| HN | Key | Year(c) | 2 | 2787.42 | 5578.86 | 147.33 | 0.00000 |
| HN | Key |  | 1 | 2789.04 | 5580.09 | 148.56 | 0.00000 |
| HR | Cos |  | 3 | 2787.14 | 5580.32 | 148.79 | 0.00000 |
| HN | Key | Veg | 3 | 2787.28 | 5580.60 | 149.07 | 0.00000 |
| HN | Key | Cloud | 2 | 2788.36 | 5580.73 | 149.20 | 0.00000 |
| HN | Key | Elev | 2 | 2788.85 | 5581.71 | 150.18 | 0.00000 |
| HN | Key | Time | 2 | 2788.94 | 5581.89 | 150.36 | 0.00000 |
| HR | Key |  | 2 | 2789.07 | 5582.17 | 150.64 | 0.00000 |
| HN | Key | Wind | 4 | 2788.36 | 5584.79 | 153.26 | 0.00000 |
| HN | Key | Gust | 5 | 2787.53 | 5585.16 | 153.63 | 0.00000 |
| HN | Cos1 |  |  |  |  |  |  |
| HR | Spoly1 |  |  |  |  |  |  |
| HN | Key | Year(f) 2 |  |  |  |  |  |
| Hawai‘i Creeper | |  |  |  |  |  |  |
| HN | Key | Detect 4 | 3 | 14661.44 | 29328.88 | 0.00 | 0.73007 |
| HN | Key | 24Detect | 2 | 14663.43 | 29330.87 | 1.99 | 0.26993 |
| HN | Key | 14Detect | 2 | 15053.98 | 30111.96 | 783.08 | 0.00000 |
| HN | Key | Year(f) | 25 | 15207.10 | 30464.55 | 1135.67 | 0.00000 |
| HN | Key | Observer | 19 | 15214.30 | 30466.80 | 1137.92 | 0.00000 |
| HN | Key | Wind | 5 | 15243.25 | 30496.53 | 1167.65 | 0.00000 |
| HN | Key | Cloud | 12 | 15243.20 | 30510.48 | 1181.60 | 0.00000 |
| HR | Cos |  | 4 | 15252.83 | 30513.66 | 1184.78 | 0.00000 |
| HN | Key | Rain | 5 | 15253.91 | 30517.83 | 1188.95 | 0.00000 |
| HN | Key | Gust | 5 | 15256.78 | 30523.58 | 1194.70 | 0.00000 |
| HN | Key | Time | 2 | 15261.96 | 30527.93 | 1199.05 | 0.00000 |
| HN | Key |  | 1 | 15264.33 | 30530.67 | 1201.79 | 0.00000 |
| HN | Key | Elev | 2 | 15263.42 | 30530.85 | 1201.97 | 0.00000 |
| HN | Key | Veg | 3 | 15263.05 | 30532.11 | 1203.23 | 0.00000 |
| HR | Key |  | 2 | 15290.75 | 30585.50 | 1256.62 | 0.00000 |
| HN | Cos1 |  |  |  |  |  |  |
| HN | Hpoly1 |  |  |  |  |  |  |
| HR | Spoly2 |  |  |  |  |  |  |
| HN | Key | Year(c) 2 |  |  |  |  |  |
| Hawai‘i ‘Ākepa | |  |  |  |  |  |  |
| HR | Key | Detect 4 | 4 | 15116.71 | 30241.44 | 0.00 | 0.99964 |
| HR | Key | 24Detect | 3 | 15125.64 | 30257.29 | 15.85 | 0.00036 |
| HR | Key | 14Detect | 3 | 15377.12 | 30760.26 | 518.82 | 0.00000 |
| HR | Key | Observer | 21 | 15483.11 | 31008.45 | 767.01 | 0.00000 |
| HR | Key | Year(f) | 26 | 15483.43 | 31019.22 | 777.78 | 0.00000 |
| HR | Key | Wind | 6 | 15548.75 | 31109.53 | 868.09 | 0.00000 |
| HR | Key | Year(c) | 3 | 15553.70 | 31113.40 | 871.96 | 0.00000 |
| HR | Cos |  | 4 | 15553.35 | 31114.70 | 873.26 | 0.00000 |
| HR | Spoly |  | 3 | 15555.78 | 31117.57 | 876.13 | 0.00000 |
| HN | Cos |  | 2 | 15556.79 | 31119.58 | 878.14 | 0.00000 |
| HR | Key | Veg | 4 | 15558.00 | 31124.01 | 882.57 | 0.00000 |
| HR | Key | Gust | 6 | 15556.55 | 31125.12 | 883.68 | 0.00000 |
| HR | Key | Rain | 6 | 15557.82 | 31127.67 | 886.23 | 0.00000 |
| HR | Key | Elev | 3 | 15560.86 | 31127.73 | 886.29 | 0.00000 |
| HR | Key | Cloud | 13 | 15551.27 | 31128.64 | 887.20 | 0.00000 |
| HR | Key |  | 2 | 15564.38 | 31132.77 | 891.33 | 0.00000 |
| HR | Key | Time | 3 | 15563.54 | 31133.09 | 891.65 | 0.00000 |
| HN | Key |  | 1 | 15594.65 | 31191.30 | 949.86 | 0.00000 |
| HN | Hpoly2 |  |  |  |  |  |  |
| ‘I‘iwi |  |  |  |  |  |  |  |
| HN | Hpoly(4,6) | 14Detect | 4 | 143991.80 | 287991.60 | 0.00 | 1.00000 |
| HN | Hpoly(4,6) | Observer | 60 | 144181.40 | 288483.00 | 491.40 | 0.00000 |
| HN | Hpoly(4,6) | Year(f) | 27 | 144507.80 | 289069.70 | 1078.10 | 0.00000 |
| HN | Hpoly(4,6) | Cloud | 14 | 144762.50 | 289553.00 | 1561.40 | 0.00000 |
| HN | Hpoly(4,6) | Wind | 7 | 144788.60 | 289591.10 | 1599.50 | 0.00000 |
| HN | Hpoly(4,6) | Rain | 7 | 144788.60 | 289591.20 | 1599.60 | 0.00000 |
| HN | Hpoly(4,6) | Veg | 5 | 144864.10 | 289738.20 | 1746.60 | 0.00000 |
| HN | Hpoly(4,6) | Gust | 7 | 144903.10 | 289820.20 | 1828.60 | 0.00000 |
| HN | Hpoly |  | 3 | 144941.50 | 289889.00 | 1897.40 | 0.00000 |
| HR | Cos |  | 4 | 145027.00 | 290062.00 | 2070.40 | 0.00000 |
| HN | Cos |  | 2 | 145037.10 | 290078.20 | 2086.60 | 0.00000 |
| HN | Key |  | 1 | 145038.20 | 290078.40 | 2086.80 | 0.00000 |
| HR | Spoly |  | 4 | 145058.80 | 290125.70 | 2134.10 | 0.00000 |
| HR | Key |  | 2 | 145175.80 | 290355.50 | 2363.90 | 0.00000 |
| HN | Hpoly(4,6) | Detect3 |  |  |  |  |  |
| HN | Hpoly(4,6) | 24Detect3 |  |  |  |  |  |
| HN | Hpoly(4,6) | Elev2 |  |  |  |  |  |
| HN | Hpoly(4,6) | Time2 |  |  |  |  |  |
| HN | Hpoly(4,6) | Year(c) 2 |  |  |  |  |  |
| ‘Apapane | |  |  |  |  |  |  |
| HR | Key | Detect | 4 | 129316.80 | 258641.70 | 0.00 | 1.00000 |
| HR | Key | 24Detect | 3 | 129333.40 | 258672.80 | 31.10 | 0.00000 |
| HR | Key | 14Detect | 3 | 130425.80 | 260857.60 | 2215.90 | 0.00000 |
| HR | Key | Year(f) | 26 | 131042.60 | 262137.20 | 3495.50 | 0.00000 |
| HR | Key | Observer | 55 | 131021.70 | 262153.70 | 3512.00 | 0.00000 |
| HR | Key | Cloud | 13 | 131566.00 | 263158.00 | 4516.30 | 0.00000 |
| HR | Key | Wind | 6 | 131592.50 | 263197.10 | 4555.40 | 0.00000 |
| HR | Key | Rain | 6 | 131653.40 | 263318.70 | 4677.00 | 0.00000 |
| HN | Cos |  | 2 | 131666.80 | 263337.70 | 4696.00 | 0.00000 |
| HR | Cos |  | 4 | 131667.60 | 263343.30 | 4701.60 | 0.00000 |
| HR | Spoly |  | 4 | 131669.60 | 263347.20 | 4705.50 | 0.00000 |
| HR | Key | Gust | 6 | 131724.90 | 263461.90 | 4820.20 | 0.00000 |
| HR | Key | Time | 3 | 131742.00 | 263489.90 | 4848.20 | 0.00000 |
| HR | Key |  | 2 | 131744.90 | 263493.80 | 4852.10 | 0.00000 |
| HR | Key | Elev | 3 | 131748.80 | 263503.60 | 4861.90 | 0.00000 |
| HN | Key |  | 1 | 131758.40 | 263518.80 | 4877.10 | 0.00000 |
| HR | Key | Veg | 4 | 131826.10 | 263660.20 | 5018.50 | 0.00000 |
| HN | Hpoly2 |  |  |  |  |  |  |
| HR | Key | Year(c) 2 |  |  |  |  |  |
| Red-billed Leiothrix | |  |  |  |  |  |  |
| HN | Cos(2,3) | 24Detect | 4 | 43894.54 | 87797.09 | 0.00 | 0.61301 |
| HN | Cos(2,3) | Detect | 5 | 43894.00 | 87798.01 | 0.92 | 0.38699 |
| HN | Cos(2,3) | 14Detect | 4 | 44930.36 | 89868.72 | 2071.63 | 0.00000 |
| HN | Cos(2,3) | Observer | 46 | 44938.88 | 89970.16 | 2173.07 | 0.00000 |
| HN | Cos(2,3) | Year(f) | 27 | 45184.84 | 90423.83 | 2626.74 | 0.00000 |
| HN | Cos(2,3) | Rain | 7 | 45240.30 | 90494.62 | 2697.53 | 0.00000 |
| HN | Cos(2,3) | Cloud | 14 | 45241.76 | 90511.55 | 2714.46 | 0.00000 |
| HN | Cos(2,3) | Wind | 7 | 45254.41 | 90522.82 | 2725.73 | 0.00000 |
| HN | Cos(2,3) | Gust | 7 | 45272.39 | 90558.79 | 2761.70 | 0.00000 |
| HN | Cos(2,3) | Veg | 5 | 45275.68 | 90561.38 | 2764.29 | 0.00000 |
| HN | Cos(2,3) | Time | 4 | 45278.57 | 90565.14 | 2768.05 | 0.00000 |
| HN | Cos(2,3) | Elev | 4 | 45281.77 | 90571.53 | 2774.44 | 0.00000 |
| HR | Cos |  | 4 | 45283.43 | 90574.86 | 2777.77 | 0.00000 |
| HN | Cos |  | 3 | 45284.58 | 90575.16 | 2778.07 | 0.00000 |
| HN | Key |  | 1 | 45309.38 | 90620.77 | 2823.68 | 0.00000 |
| HN | Hpoly |  | 1 | 45309.38 | 90620.77 | 2823.68 | 0.00000 |
| HR | Key |  | 2 | 45367.73 | 90739.47 | 2942.38 | 0.00000 |
| HR | Spoly2 |  |  |  |  |  |  |
| HN | Cos(2,3) | Year(c) 2 |  |  |  |  |  |
| Japanese White-eye | |  |  |  |  |  |  |
| HN | Key | 24Detect | 3 | 27831.74 | 55669.48 | 0.00 | 1.00000 |
| HN | Key | Detect | 4 | 27885.10 | 55778.20 | 108.72 | 0.00000 |
| HN | Key | Observer | 32 | 28146.27 | 56356.81 | 687.33 | 0.00000 |
| HN | Key | Year(f) | 26 | 28288.71 | 56629.61 | 960.13 | 0.00000 |
| HR | Spoly |  | 3 | 28352.16 | 56710.32 | 1040.84 | 0.00000 |
| HR | Key |  | 2 | 28373.99 | 56751.98 | 1082.50 | 0.00000 |
| HN | Key | Veg | 4 | 28381.24 | 56770.48 | 1101.00 | 0.00000 |
| HN | Key | 14Detect | 3 | 28384.76 | 56775.52 | 1106.04 | 0.00000 |
| HN | Key | Time | 3 | 28384.79 | 56775.59 | 1106.11 | 0.00000 |
| HN | Key | Wind | 6 | 28381.80 | 56775.61 | 1106.13 | 0.00000 |
| HN | Key | Elev | 3 | 28384.60 | 56775.81 | 1106.33 | 0.00000 |
| HN | Key | Gust | 6 | 28382.99 | 56778.00 | 1108.52 | 0.00000 |
| HN | Key | Rain | 6 | 28384.65 | 56781.31 | 1111.83 | 0.00000 |
| HN | Key | Cloud | 13 | 28382.73 | 56791.52 | 1122.04 | 0.00000 |
| HN | Key |  | 1 | 28395.13 | 56792.27 | 1122.79 | 0.00000 |
| HN | Cos2 |  |  |  |  |  |  |
| HN | Hpoly2 |  |  |  |  |  |  |
| HR | Cos2 |  |  |  |  |  |  |
| HN | Key | Year(c) 2 |  |  |  |  |  |

1 Key model selected.

2 Parameters highly correlated.

3 Failed to converge.

4 Parsimonious model with 24Detect used because of bootstrap errors.

Table S4. Annual counts, and abundance and 95% CI estimates for forest birds at Hakalau in open and closed forest strata. Missing year in the series indicated with a NA.

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Species |  |  | 95% Credible | |  | 95% Confidence | |  | 95% Credible | |
| Year | Count | State-space | lower | upper | DISTANCE | lower | upper | State-space | lower | upper |
| Hawai‘i ‘Elepaio |  |  |  |  |  |  |  |  |  |  |
| Open forest |  |  |  |  |  |  |  |  |  |  |
| 1987 | 849 | 978 | 794 | 1,194 | 10,521 | 8,116 | 12,548 | 11,440 | 9,634 | 13,547 |
| 1988 | 1,516 | 1,029 | 832 | 1,381 | 14,767 | 11,794 | 17,332 | 11,912 | 10,097 | 14,717 |
| 1989 | 884 | 952 | 808 | 1,118 | 11,195 | 8,713 | 13,427 | 11,361 | 9,927 | 13,111 |
| 1990 | 961 | 921 | 773 | 1,069 | 11,436 | 8,918 | 13,658 | 11,044 | 9,521 | 12,606 |
| 1991 | 624 | 863 | 648 | 1,023 | 7,451 | 5,681 | 9,050 | 10,393 | 7,851 | 12,198 |
| 1992 | 761 | 877 | 713 | 1,020 | 10,492 | 8,135 | 12,747 | 10,853 | 9,133 | 12,357 |
| 1993 | 1,005 | 914 | 780 | 1,075 | 11,658 | 9,078 | 14,068 | 11,264 | 9,876 | 12,780 |
| 1994 | 1,021 | 925 | 791 | 1,119 | 12,044 | 9,299 | 14,332 | 11,536 | 10,150 | 13,364 |
| 1995 | 1,067 | 921 | 791 | 1,124 | 12,904 | 10,106 | 15,265 | 11,738 | 10,256 | 13,795 |
| 1996 | 965 | 886 | 758 | 1,033 | 13,162 | 10,249 | 15,867 | 11,626 | 10,212 | 13,560 |
| 1997 | 668 | 829 | 662 | 954 | 9,313 | 7,331 | 11,302 | 10,984 | 9,183 | 12,516 |
| 1998 | 731 | 822 | 675 | 947 | 9,960 | 7,574 | 12,166 | 10,987 | 9,233 | 12,562 |
| 1999 | 810 | 829 | 695 | 953 | 11,291 | 8,897 | 13,495 | 11,270 | 9,787 | 12,803 |
| 2000 | 758 | 826 | 700 | 947 | 10,968 | 8,612 | 12,831 | 11,448 | 9,994 | 13,123 |
| 2001 | 954 | 851 | 734 | 1,006 | 13,679 | 10,637 | 16,327 | 11,925 | 10,433 | 14,152 |
| 2002 | 800 | 836 | 723 | 971 | 11,291 | 8,530 | 13,754 | 11,741 | 10,360 | 13,526 |
| 2003 | 900 | 842 | 730 | 996 | 13,031 | 10,195 | 15,405 | 11,971 | 10,514 | 14,033 |
| 2004 | 859 | 833 | 719 | 976 | 12,406 | 9,739 | 14,669 | 11,876 | 10,441 | 13,775 |
| 2005 | 821 | 826 | 716 | 978 | 11,412 | 8,707 | 14,061 | 11,734 | 10,329 | 13,533 |
| 2006 | 976 | 830 | 712 | 1,012 | 13,790 | 10,398 | 17,045 | 11,896 | 10,326 | 14,201 |
| 2007 | 834 | 797 | 684 | 938 | 12,319 | 9,694 | 14,543 | 11,490 | 10,016 | 13,325 |
| 2008 | 646 | 757 | 616 | 902 | 9,290 | 7,000 | 11,413 | 10,824 | 9,029 | 12,449 |
| 2009 | NA | 749 | 588 | 908 | NA | NA | NA | 10,701 | 8,164 | 12,465 |
| 2010 | 657 | 741 | 607 | 885 | 9,307 | 6,828 | 11,719 | 10,600 | 8,787 | 12,345 |
| 2011 | 796 | 753 | 629 | 908 | 11,497 | 8,731 | 14,095 | 10,857 | 9,241 | 12,549 |
| 2012 | 741 | 745 | 608 | 915 | 10,262 | 7,653 | 12,792 | 10,736 | 8,903 | 12,670 |
| Closed forest |  |  |  |  |  |  |  |  |  |  |
| 1999 | 1,168 | 1,125 | 889 | 1,370 | 9,500 | 7,192 | 11,496 | 9,219 | 7,294 | 11,426 |
| 2000 | 935 | 1,009 | 846 | 1,238 | 7,968 | 6,138 | 9,736 | 8,660 | 7,056 | 10,625 |
| 2001 | 935 | 1,000 | 853 | 1,196 | 8,204 | 6,210 | 9,992 | 8,702 | 7,255 | 10,493 |
| 2002 | 1,277 | 1,127 | 911 | 1,358 | 11,043 | 8,471 | 13,129 | 9,338 | 7,605 | 11,474 |
| 2003 | 1,032 | 1,018 | 863 | 1,187 | 8,405 | 6,341 | 10,344 | 8,471 | 7,140 | 10,122 |
| 2004 | 768 | 895 | 736 | 1,086 | 6,444 | 4,486 | 8,337 | 7,747 | 6,201 | 9,507 |
| 2005 | 1,063 | 1,001 | 834 | 1,171 | 8,731 | 6,291 | 11,091 | 8,289 | 6,882 | 9,881 |
| 2006 | 1,049 | 997 | 829 | 1,178 | 8,872 | 6,223 | 11,124 | 8,310 | 6,861 | 10,120 |
| 2007 | 1,000 | 950 | 792 | 1,115 | 8,752 | 6,604 | 10,553 | 8,078 | 6,665 | 9,707 |
| 2008 | 753 | 829 | 690 | 1,003 | 6,367 | 4,584 | 8,181 | 7,214 | 5,831 | 8,700 |
| 2009 | NA | 806 | 599 | 1,024 | NA | NA | NA | 7,139 | 5,205 | 8,968 |
| 2010 | 746 | 800 | 670 | 971 | 6,316 | 4,504 | 8,009 | 6,967 | 5,634 | 8,465 |
| 2011 | 855 | 842 | 695 | 991 | 7,584 | 5,311 | 9,843 | 7,316 | 5,994 | 8,902 |
| 2012 | 889 | 856 | 676 | 1,038 | 7,886 | 5,671 | 9,745 | 7,460 | 5,835 | 9,369 |
| ‘Ōma‘o |  |  |  |  |  |  |  |  |  |  |
| Open forest |  |  |  |  |  |  |  |  |  |  |
| 1987 | 2,668 | 2,693 | 2,148 | 3,305 | 9,538 | 8,541 | 10,648 | 9,002 | 7,338 | 11,128 |
| 1988 | 3,418 | 2,792 | 2,155 | 3,467 | 9,570 | 8,316 | 10,696 | 8,965 | 7,499 | 10,782 |
| 1989 | 2,500 | 2,497 | 2,092 | 2,940 | 9,901 | 8,752 | 11,166 | 8,836 | 7,520 | 10,565 |
| 1990 | 2,468 | 2,309 | 1,981 | 2,690 | 8,891 | 7,814 | 10,044 | 8,377 | 7,173 | 9,658 |
| 1991 | 1,528 | 1,982 | 1,540 | 2,443 | 5,266 | 4,395 | 6,126 | 7,667 | 5,729 | 9,165 |
| 1992 | 1,843 | 2,007 | 1,649 | 2,393 | 8,398 | 7,483 | 9,439 | 8,029 | 6,709 | 9,342 |
| 1993 | 2,093 | 2,102 | 1,780 | 2,437 | 7,405 | 6,486 | 8,349 | 8,094 | 6,843 | 9,309 |
| 1994 | 2,335 | 2,170 | 1,849 | 2,552 | 8,876 | 7,974 | 9,840 | 8,369 | 7,152 | 9,606 |
| 1995 | 2,133 | 2,117 | 1,807 | 2,479 | 7,873 | 6,877 | 8,983 | 8,362 | 7,087 | 9,590 |
| 1996 | 2,000 | 2,057 | 1,746 | 2,384 | 8,356 | 7,496 | 9,271 | 8,521 | 7,303 | 9,807 |
| 1997 | 1,969 | 2,028 | 1,725 | 2,346 | 8,976 | 7,969 | 9,961 | 8,744 | 7,500 | 10,139 |
| 1998 | 2,076 | 2,040 | 1,738 | 2,345 | 8,530 | 7,665 | 9,427 | 8,792 | 7,552 | 10,103 |
| 1999 | 1,908 | 1,988 | 1,682 | 2,306 | 9,016 | 8,041 | 9,943 | 8,978 | 7,737 | 10,352 |
| 2000 | 1,949 | 1,996 | 1,702 | 2,311 | 8,958 | 8,099 | 9,815 | 9,113 | 7,868 | 10,590 |
| 2001 | 2,061 | 2,018 | 1,724 | 2,329 | 9,950 | 8,998 | 10,913 | 9,370 | 8,100 | 11,028 |
| 2002 | 1,979 | 1,993 | 1,697 | 2,307 | 9,575 | 8,482 | 10,568 | 9,375 | 8,113 | 10,905 |
| 2003 | 1,715 | 1,955 | 1,638 | 2,271 | 7,883 | 6,951 | 8,804 | 9,294 | 7,828 | 10,865 |
| 2004 | 2,449 | 2,137 | 1,810 | 2,545 | 11,892 | 10,898 | 12,909 | 9,895 | 8,470 | 11,838 |
| 2005 | 1,881 | 2,054 | 1,746 | 2,394 | 8,830 | 7,820 | 9,927 | 9,728 | 8,351 | 11,446 |
| 2006 | 2,622 | 2,194 | 1,813 | 2,687 | 12,270 | 10,994 | 13,608 | 10,133 | 8,667 | 12,261 |
| 2007 | 1,947 | 2,020 | 1,723 | 2,348 | 10,035 | 8,929 | 11,057 | 9,802 | 8,377 | 11,475 |
| 2008 | 1,823 | 1,938 | 1,626 | 2,294 | 8,502 | 7,444 | 9,611 | 9,418 | 7,842 | 11,036 |
| 2009 | NA | 1,918 | 1,492 | 2,358 | NA | NA | NA | 9,404 | 7,433 | 11,294 |
| 2010 | 1,707 | 1,889 | 1,555 | 2,258 | 8,298 | 7,158 | 9,523 | 9,325 | 7,690 | 11,076 |
| 2011 | 1,908 | 1,987 | 1,667 | 2,355 | 8,510 | 7,401 | 9,678 | 9,571 | 7,961 | 11,333 |
| 2012 | 2,556 | 2,189 | 1,710 | 2,747 | 12,358 | 10,967 | 13,713 | 10,312 | 8,333 | 12,796 |
| Closed forest |  |  |  |  |  |  |  |  |  |  |
| 1999 | 2,646 | 2,413 | 1,694 | 3,084 | 7,232 | 6,401 | 8,032 | 6,569 | 4,744 | 8,482 |
| 2000 | 2,046 | 2,101 | 1,656 | 2,645 | 5,718 | 5,058 | 6,445 | 5,853 | 4,679 | 7,410 |
| 2001 | 1,849 | 1,954 | 1,569 | 2,457 | 5,352 | 4,678 | 6,008 | 5,541 | 4,491 | 6,813 |
| 2002 | 1,936 | 1,934 | 1,557 | 2,367 | 5,491 | 4,810 | 6,229 | 5,465 | 4,346 | 6,617 |
| 2003 | 1,611 | 1,801 | 1,442 | 2,264 | 4,398 | 3,654 | 5,156 | 5,009 | 3,918 | 6,299 |
| 2004 | 2,063 | 1,958 | 1,581 | 2,368 | 5,595 | 4,860 | 6,329 | 5,417 | 4,364 | 6,536 |
| 2005 | 1,857 | 1,887 | 1,531 | 2,316 | 5,267 | 4,406 | 6,137 | 5,375 | 4,372 | 6,512 |
| 2006 | 1,902 | 1,885 | 1,519 | 2,294 | 5,490 | 4,715 | 6,280 | 5,435 | 4,430 | 6,632 |
| 2007 | 1,973 | 1,873 | 1,488 | 2,289 | 6,061 | 5,288 | 6,863 | 5,544 | 4,368 | 6,775 |
| 2008 | 1,624 | 1,693 | 1,333 | 2,108 | 4,807 | 4,056 | 5,562 | 5,021 | 4,007 | 6,248 |
| 2009 | NA | 1,555 | 947 | 2,224 | NA | NA | NA | 4,634 | 3,119 | 6,242 |
| 2010 | 1,085 | 1,428 | 1,036 | 2,035 | 3,281 | 2,520 | 4,054 | 4,322 | 3,081 | 5,953 |
| 2011 | 2,016 | 1,850 | 1,405 | 2,293 | 5,599 | 4,636 | 6,609 | 5,336 | 4,150 | 6,709 |
| 2012 | 2,270 | 2,024 | 1,381 | 2,642 | 6,973 | 5,799 | 8,149 | 6,084 | 4,250 | 8,040 |
| Hawai‘i ‘Amakihi | |  |  |  |  |  |  |  |  |  |
| Open forest |  |  |  |  |  |  |  |  |  |  |
| 1987 | 3,576 | 3,786 | 3,094 | 4,533 | 24,717 | 22,176 | 27,302 | 26,952 | 21,368 | 33,442 |
| 1988 | 3,484 | 3,841 | 3,192 | 4,535 | 23,789 | 20,991 | 26,659 | 27,585 | 21,984 | 33,553 |
| 1989 | 3,788 | 4,018 | 3,432 | 4,637 | 29,177 | 26,285 | 32,170 | 29,916 | 25,179 | 34,947 |
| 1990 | 4,773 | 4,306 | 3,717 | 5,033 | 36,057 | 32,765 | 39,798 | 32,675 | 27,694 | 38,934 |
| 1991 | 4,761 | 4,427 | 3,797 | 5,217 | 35,511 | 32,310 | 38,975 | 33,851 | 28,797 | 40,184 |
| 1992 | 4,467 | 4,450 | 3,837 | 5,217 | 37,737 | 34,513 | 41,461 | 34,926 | 29,545 | 42,050 |
| 1993 | 5,381 | 4,542 | 3,861 | 5,445 | 41,393 | 37,676 | 45,330 | 35,378 | 29,992 | 42,955 |
| 1994 | 3,964 | 4,302 | 3,713 | 4,990 | 28,288 | 25,335 | 30,979 | 32,802 | 27,339 | 38,243 |
| 1995 | 3,774 | 4,250 | 3,672 | 4,892 | 28,772 | 25,837 | 31,904 | 33,125 | 27,801 | 38,642 |
| 1996 | 5,818 | 4,490 | 3,822 | 5,429 | 48,571 | 43,785 | 53,901 | 36,996 | 30,820 | 47,355 |
| 1997 | 3,876 | 4,204 | 3,618 | 4,848 | 33,249 | 30,045 | 36,793 | 34,784 | 30,033 | 40,974 |
| 1998 | 4,320 | 4,143 | 3,593 | 4,723 | 36,358 | 32,864 | 40,398 | 34,448 | 29,665 | 40,293 |
| 1999 | 3,856 | 3,984 | 3,385 | 4,559 | 31,739 | 27,700 | 35,966 | 32,908 | 28,006 | 37,903 |
| 2000 | 3,061 | 3,824 | 3,100 | 4,448 | 26,521 | 24,048 | 29,139 | 31,798 | 25,883 | 37,075 |
| 2001 | 4,184 | 4,022 | 3,474 | 4,578 | 35,872 | 33,055 | 39,214 | 33,903 | 29,129 | 39,218 |
| 2002 | 4,369 | 4,107 | 3,560 | 4,685 | 36,506 | 32,909 | 39,613 | 34,518 | 29,639 | 40,080 |
| 2003 | 3,845 | 4,052 | 3,476 | 4,646 | 32,743 | 28,991 | 36,597 | 33,985 | 29,125 | 39,244 |
| 2004 | 3,828 | 4,087 | 3,521 | 4,662 | 32,454 | 29,112 | 35,868 | 34,206 | 29,266 | 39,665 |
| 2005 | 5,143 | 4,266 | 3,682 | 5,049 | 42,058 | 37,919 | 46,305 | 35,679 | 30,389 | 42,476 |
| 2006 | 3,854 | 4,074 | 3,494 | 4,684 | 31,484 | 28,461 | 34,543 | 33,448 | 28,308 | 38,704 |
| 2007 | 3,379 | 3,961 | 3,311 | 4,611 | 27,596 | 24,626 | 30,560 | 32,302 | 26,151 | 38,145 |
| 2008 | 3,968 | 4,084 | 3,450 | 4,730 | 31,959 | 28,140 | 35,953 | 33,430 | 27,802 | 39,291 |
| 2009 | NA | 4,228 | 3,486 | 4,987 | NA | NA | NA | 34,625 | 27,745 | 42,123 |
| 2010 | 4,207 | 4,356 | 3,714 | 5,082 | 34,189 | 30,860 | 37,818 | 35,673 | 30,139 | 41,954 |
| 2011 | 5,134 | 4,590 | 3,843 | 5,443 | 42,351 | 38,206 | 46,564 | 37,938 | 31,421 | 45,225 |
| 2012 | 4,704 | 4,612 | 3,810 | 5,583 | 37,393 | 33,254 | 41,721 | 37,759 | 31,178 | 45,911 |
| Closed forest |  |  |  |  |  |  |  |  |  |  |
| 1999 | 2,611 | 2,265 | 1,628 | 3,031 | 12,637 | 11,039 | 14,300 | 11,204 | 8,257 | 14,832 |
| 2000 | 1,620 | 2,003 | 1,501 | 2,593 | 8,222 | 6,805 | 9,711 | 10,030 | 7,697 | 13,292 |
| 2001 | 2,151 | 2,108 | 1,660 | 2,637 | 11,056 | 9,413 | 12,767 | 10,630 | 8,341 | 13,401 |
| 2002 | 2,468 | 2,163 | 1,696 | 2,748 | 12,540 | 10,956 | 14,148 | 10,894 | 8,651 | 13,876 |
| 2003 | 1,674 | 1,963 | 1,523 | 2,439 | 8,582 | 7,010 | 10,164 | 9,881 | 7,737 | 12,356 |
| 2004 | 1,968 | 2,029 | 1,614 | 2,517 | 10,003 | 8,427 | 11,719 | 10,097 | 8,143 | 12,463 |
| 2005 | 2,508 | 2,146 | 1,690 | 2,723 | 11,869 | 9,598 | 14,088 | 10,390 | 8,281 | 13,028 |
| 2006 | 1,967 | 2,001 | 1,608 | 2,451 | 8,768 | 7,333 | 10,271 | 9,539 | 7,513 | 11,670 |
| 2007 | 1,959 | 1,922 | 1,535 | 2,366 | 9,614 | 8,089 | 11,236 | 9,389 | 7,358 | 11,542 |
| 2008 | 1,365 | 1,759 | 1,257 | 2,275 | 7,026 | 5,582 | 8,646 | 8,723 | 6,439 | 11,239 |
| 2009 | NA | 1,860 | 1,240 | 2,468 | NA | NA | NA | 9,213 | 6,309 | 12,249 |
| 2010 | 1,746 | 1,909 | 1,477 | 2,435 | 8,801 | 7,060 | 10,523 | 9,623 | 7,483 | 12,281 |
| 2011 | 2,371 | 2,103 | 1,581 | 2,680 | 12,144 | 10,076 | 14,377 | 10,739 | 8,051 | 13,828 |
| 2012 | 2,238 | 2,115 | 1,547 | 2,816 | 11,622 | 9,468 | 13,831 | 10,932 | 7,895 | 14,519 |
| ‘Akiapōlā‘au |  |  |  |  |  |  |  |  |  |  |
| Open forest |  |  |  |  |  |  |  |  |  |  |
| 1987 | 98 | 78 | 53 | 123 | 515 | 229 | 896 | 353 | 214 | 572 |
| 1988 | 113 | 76 | 54 | 111 | 443 | 232 | 716 | 337 | 223 | 492 |
| 1989 | 45 | 71 | 50 | 96 | 168 | 29 | 349 | 310 | 207 | 437 |
| 1990 | 69 | 70 | 50 | 94 | 328 | 157 | 557 | 315 | 218 | 435 |
| 1991 | 61 | 69 | 49 | 92 | 310 | 133 | 554 | 315 | 219 | 431 |
| 1992 | 51 | 69 | 47 | 90 | 254 | 91 | 456 | 313 | 212 | 423 |
| 1993 | 52 | 70 | 51 | 91 | 200 | 80 | 373 | 317 | 215 | 424 |
| 1994 | 119 | 75 | 57 | 104 | 487 | 221 | 820 | 343 | 249 | 475 |
| 1995 | 51 | 75 | 56 | 100 | 228 | 59 | 467 | 348 | 256 | 469 |
| 1996 | 177 | 80 | 60 | 127 | 869 | 524 | 1,283 | 388 | 274 | 608 |
| 1997 | 83 | 76 | 59 | 106 | 403 | 141 | 754 | 373 | 272 | 527 |
| 1998 | 76 | 73 | 55 | 98 | 366 | 178 | 618 | 361 | 265 | 494 |
| 1999 | 46 | 70 | 49 | 89 | 256 | 84 | 481 | 351 | 246 | 471 |
| 2000 | 66 | 71 | 50 | 91 | 365 | 162 | 614 | 357 | 256 | 476 |
| 2001 | 66 | 70 | 50 | 89 | 368 | 146 | 661 | 361 | 262 | 481 |
| 2002 | 51 | 70 | 49 | 89 | 256 | 87 | 461 | 359 | 246 | 479 |
| 2003 | 100 | 73 | 54 | 95 | 555 | 298 | 884 | 378 | 272 | 515 |
| 2004 | 51 | 71 | 50 | 92 | 280 | 131 | 466 | 369 | 261 | 494 |
| 2005 | 77 | 73 | 53 | 95 | 331 | 112 | 631 | 375 | 267 | 498 |
| 2006 | 55 | 74 | 52 | 97 | 305 | 106 | 534 | 385 | 274 | 516 |
| 2007 | 95 | 78 | 57 | 105 | 493 | 225 | 813 | 411 | 298 | 577 |
| 2008 | 101 | 80 | 57 | 111 | 562 | 233 | 1,010 | 427 | 304 | 617 |
| 2009 | NA | 79 | 54 | 112 | NA | NA | NA | 426 | 286 | 624 |
| 2010 | 64 | 78 | 54 | 107 | 357 | 126 | 638 | 423 | 290 | 599 |
| 2011 | 113 | 79 | 54 | 111 | 626 | 295 | 1,051 | 437 | 294 | 637 |
| 2012 | 56 | 76 | 47 | 110 | 308 | 130 | 535 | 422 | 265 | 627 |
| Closed forest |  |  |  |  |  |  |  |  |  |  |
| 1999 | 230 | 160 | 42 | 422 | 757 | 423 | 1,160 | 546 | 145 | 1,466 |
| 2000 | 46 | 108 | 36 | 254 | 152 | 28 | 354 | 333 | 106 | 841 |
| 2001 | 140 | 115 | 43 | 262 | 389 | 133 | 786 | 360 | 126 | 838 |
| 2002 | 149 | 105 | 43 | 230 | 490 | 251 | 793 | 343 | 129 | 767 |
| 2003 | 42 | 77 | 30 | 155 | 104 | 0 | 238 | 225 | 77 | 503 |
| 2004 | 95 | 77 | 30 | 165 | 312 | 132 | 543 | 249 | 91 | 541 |
| 2005 | 48 | 64 | 24 | 131 | 157 | 0 | 362 | 199 | 74 | 438 |
| 2006 | 66 | 58 | 22 | 121 | 162 | 0 | 348 | 172 | 62 | 356 |
| 2007 | 14 | 46 | 13 | 97 | 44 | 0 | 168 | 135 | 37 | 311 |
| 2008 | 94 | 59 | 22 | 131 | 310 | 45 | 640 | 199 | 69 | 465 |
| 2009 | NA | 58 | 16 | 155 | NA | NA | NA | 222 | 46 | 871 |
| 2010 | 34 | 51 | 18 | 116 | 111 | 0 | 289 | 164 | 59 | 379 |
| 2011 | 113 | 60 | 19 | 155 | 371 | 103 | 726 | 218 | 61 | 533 |
| 2012 | 32 | 47 | 14 | 121 | 104 | 0 | 274 | 153 | 41 | 417 |
| Hawai‘i Creeper |  |  |  |  |  |  |  |  |  |  |
| Open forest |  |  |  |  |  |  |  |  |  |  |
| 1987 | 439 | 420 | 298 | 562 | 4,001 | 2,671 | 5,525 | 3,970 | 2,764 | 5,455 |
| 1988 | 404 | 420 | 312 | 543 | 3,391 | 2,121 | 4,755 | 4,024 | 2,860 | 5,305 |
| 1989 | 298 | 422 | 321 | 535 | 2,968 | 1,969 | 4,315 | 4,133 | 3,032 | 5,388 |
| 1990 | 616 | 443 | 346 | 559 | 6,755 | 4,868 | 8,794 | 4,433 | 3,370 | 5,899 |
| 1991 | 401 | 445 | 350 | 553 | 4,350 | 3,006 | 5,609 | 4,485 | 3,455 | 5,760 |
| 1992 | 487 | 452 | 355 | 563 | 5,780 | 4,215 | 7,490 | 4,583 | 3,513 | 5,831 |
| 1993 | 309 | 452 | 350 | 557 | 2,777 | 1,775 | 3,981 | 4,527 | 3,286 | 5,673 |
| 1994 | 582 | 474 | 377 | 589 | 5,427 | 4,163 | 6,841 | 4,750 | 3,622 | 5,977 |
| 1995 | 338 | 481 | 383 | 595 | 2,825 | 1,699 | 4,303 | 4,850 | 3,586 | 6,095 |
| 1996 | 838 | 515 | 415 | 675 | 8,842 | 6,677 | 11,342 | 5,312 | 4,156 | 7,085 |
| 1997 | 606 | 515 | 411 | 654 | 6,914 | 5,109 | 8,840 | 5,432 | 4,270 | 7,079 |
| 1998 | 381 | 506 | 396 | 624 | 4,164 | 2,852 | 5,649 | 5,422 | 4,195 | 6,902 |
| 1999 | 456 | 518 | 408 | 645 | 4,897 | 3,474 | 6,332 | 5,589 | 4,283 | 7,076 |
| 2000 | 505 | 536 | 430 | 669 | 5,812 | 4,187 | 7,701 | 5,843 | 4,570 | 7,553 |
| 2001 | 643 | 560 | 453 | 721 | 7,121 | 5,408 | 9,075 | 6,151 | 4,820 | 8,127 |
| 2002 | 969 | 580 | 464 | 770 | 10,736 | 8,338 | 13,345 | 6,405 | 4,986 | 8,914 |
| 2003 | 430 | 560 | 445 | 699 | 4,775 | 3,336 | 6,333 | 6,227 | 4,868 | 8,062 |
| 2004 | 646 | 564 | 450 | 708 | 7,420 | 5,578 | 9,499 | 6,355 | 4,997 | 8,237 |
| 2005 | 464 | 560 | 440 | 688 | 5,174 | 3,582 | 6,711 | 6,331 | 4,814 | 8,097 |
| 2006 | 549 | 566 | 442 | 707 | 6,495 | 4,870 | 8,406 | 6,492 | 5,010 | 8,360 |
| 2007 | 609 | 575 | 444 | 721 | 7,172 | 5,550 | 8,991 | 6,638 | 5,053 | 8,540 |
| 2008 | 595 | 579 | 443 | 732 | 6,819 | 4,737 | 9,064 | 6,726 | 5,100 | 8,755 |
| 2009 | NA | 582 | 438 | 749 | NA | NA | NA | 6,781 | 4,934 | 9,020 |
| 2010 | 586 | 584 | 446 | 748 | 7,083 | 5,178 | 9,331 | 6,848 | 5,048 | 9,040 |
| 2011 | 606 | 585 | 436 | 753 | 6,897 | 4,945 | 9,205 | 6,865 | 4,943 | 9,093 |
| 2012 | 463 | 583 | 416 | 779 | 5,064 | 3,592 | 6,743 | 6,854 | 4,536 | 9,470 |
| Closed forest |  |  |  |  |  |  |  |  |  |  |
| 1999 | 867 | 908 | 699 | 1,160 | 5,455 | 4,220 | 6,940 | 6,018 | 4,559 | 7,758 |
| 2000 | 861 | 913 | 735 | 1,120 | 5,976 | 4,319 | 7,675 | 6,171 | 4,871 | 7,664 |
| 2001 | 903 | 943 | 776 | 1,142 | 6,004 | 4,351 | 7,920 | 6,402 | 5,152 | 7,917 |
| 2002 | 1,372 | 1,035 | 823 | 1,412 | 9,181 | 7,200 | 11,263 | 7,004 | 5,531 | 9,312 |
| 2003 | 947 | 950 | 791 | 1,136 | 6,870 | 5,029 | 9,044 | 6,575 | 5,337 | 8,177 |
| 2004 | 695 | 888 | 679 | 1,070 | 4,657 | 3,438 | 5,960 | 6,076 | 4,573 | 7,444 |
| 2005 | 1,111 | 964 | 804 | 1,168 | 8,058 | 5,946 | 10,437 | 6,577 | 5,329 | 8,358 |
| 2006 | 902 | 939 | 788 | 1,117 | 5,588 | 3,503 | 7,822 | 6,220 | 4,987 | 7,637 |
| 2007 | 1,027 | 954 | 796 | 1,157 | 6,566 | 4,827 | 8,386 | 6,310 | 5,076 | 7,785 |
| 2008 | 894 | 926 | 759 | 1,110 | 5,972 | 4,358 | 7,847 | 6,185 | 4,911 | 7,659 |
| 2009 | NA | 922 | 704 | 1,189 | NA | NA | NA | 6,191 | 4,408 | 8,175 |
| 2010 | 864 | 905 | 742 | 1,104 | 6,146 | 4,086 | 8,425 | 6,189 | 4,868 | 7,746 |
| 2011 | 887 | 910 | 731 | 1,119 | 5,849 | 4,152 | 7,896 | 6,137 | 4,825 | 7,763 |
| 2012 | 921 | 918 | 717 | 1,155 | 6,331 | 4,658 | 8,247 | 6,252 | 4,740 | 8,156 |
| Hawai‘i ‘Ākepa |  |  |  |  |  |  |  |  |  |  |
| Open forest |  |  |  |  |  |  |  |  |  |  |
| 1987 | 605 | 577 | 393 | 809 | 4,783 | 3,341 | 6,306 | 4,955 | 3,351 | 7,056 |
| 1988 | 592 | 555 | 396 | 746 | 5,444 | 3,912 | 7,342 | 4,987 | 3,510 | 6,829 |
| 1989 | 434 | 507 | 353 | 701 | 4,366 | 2,944 | 6,093 | 4,724 | 3,347 | 6,413 |
| 1990 | 399 | 490 | 328 | 693 | 3,687 | 2,502 | 4,980 | 4,528 | 3,134 | 6,194 |
| 1991 | 406 | 503 | 347 | 686 | 3,478 | 2,203 | 4,873 | 4,668 | 3,117 | 6,278 |
| 1992 | 548 | 556 | 401 | 726 | 5,672 | 4,127 | 7,533 | 5,288 | 3,868 | 6,971 |
| 1993 | 768 | 619 | 453 | 849 | 7,227 | 5,337 | 9,018 | 5,816 | 4,234 | 8,125 |
| 1994 | 567 | 600 | 453 | 805 | 4,999 | 3,504 | 6,802 | 5,620 | 4,141 | 7,562 |
| 1995 | 564 | 617 | 456 | 836 | 5,406 | 3,715 | 7,360 | 5,935 | 4,346 | 8,060 |
| 1996 | 949 | 688 | 485 | 994 | 9,690 | 7,310 | 12,421 | 6,794 | 4,745 | 9,881 |
| 1997 | 674 | 639 | 475 | 870 | 7,046 | 5,350 | 9,059 | 6,463 | 4,696 | 9,087 |
| 1998 | 569 | 596 | 447 | 799 | 5,887 | 4,321 | 7,695 | 6,064 | 4,475 | 8,205 |
| 1999 | 487 | 571 | 418 | 767 | 4,974 | 3,613 | 6,429 | 5,832 | 4,208 | 7,924 |
| 2000 | 621 | 598 | 447 | 808 | 6,549 | 4,827 | 8,471 | 6,173 | 4,586 | 8,456 |
| 2001 | 663 | 615 | 459 | 846 | 6,831 | 5,192 | 8,739 | 6,300 | 4,643 | 8,792 |
| 2002 | 815 | 626 | 455 | 884 | 8,218 | 6,373 | 10,472 | 6,314 | 4,563 | 8,937 |
| 2003 | 455 | 542 | 398 | 713 | 4,639 | 3,313 | 6,321 | 5,561 | 4,107 | 7,413 |
| 2004 | 712 | 545 | 390 | 739 | 7,294 | 5,477 | 9,306 | 5,562 | 3,956 | 7,555 |
| 2005 | 292 | 448 | 278 | 628 | 2,824 | 1,663 | 3,999 | 4,582 | 2,745 | 6,437 |
| 2006 | 250 | 441 | 255 | 616 | 2,636 | 1,788 | 3,578 | 4,570 | 2,653 | 6,427 |
| 2007 | 822 | 571 | 407 | 819 | 8,546 | 6,709 | 10,575 | 5,850 | 4,166 | 8,515 |
| 2008 | 759 | 591 | 410 | 860 | 7,606 | 5,356 | 9,931 | 6,087 | 4,221 | 9,312 |
| 2009 | NA | 557 | 371 | 883 | NA | NA | NA | 5,725 | 3,726 | 9,065 |
| 2010 | 521 | 513 | 361 | 701 | 5,422 | 3,894 | 7,311 | 5,345 | 3,723 | 7,463 |
| 2011 | 394 | 472 | 325 | 657 | 4,158 | 2,734 | 5,922 | 5,000 | 3,469 | 6,996 |
| 2012 | 451 | 474 | 311 | 670 | 4,751 | 3,256 | 6,505 | 5,037 | 3,329 | 7,214 |
| Closed forest |  |  |  |  |  |  |  |  |  |  |
| 1999 | 929 | 793 | 536 | 1,099 | 5,526 | 4,235 | 6,934 | 4,841 | 3,261 | 6,727 |
| 2000 | 583 | 723 | 518 | 976 | 3,527 | 2,393 | 4,922 | 4,476 | 3,188 | 5,960 |
| 2001 | 602 | 746 | 537 | 991 | 3,760 | 2,693 | 5,070 | 4,615 | 3,349 | 6,026 |
| 2002 | 1,223 | 882 | 643 | 1,265 | 7,175 | 5,566 | 8,994 | 5,299 | 3,838 | 7,447 |
| 2003 | 737 | 824 | 622 | 1,074 | 4,470 | 3,057 | 6,018 | 4,967 | 3,798 | 6,378 |
| 2004 | 926 | 858 | 648 | 1,141 | 5,522 | 4,180 | 7,020 | 5,116 | 3,908 | 6,576 |
| 2005 | 857 | 842 | 633 | 1,098 | 4,857 | 2,943 | 7,142 | 4,970 | 3,767 | 6,215 |
| 2006 | 656 | 804 | 588 | 1,056 | 3,788 | 2,343 | 5,404 | 4,804 | 3,455 | 6,122 |
| 2007 | 919 | 875 | 658 | 1,145 | 5,316 | 3,915 | 6,927 | 5,206 | 3,983 | 6,610 |
| 2008 | 1,059 | 919 | 667 | 1,249 | 6,392 | 4,594 | 8,142 | 5,502 | 4,153 | 7,240 |
| 2009 | NA | 893 | 589 | 1,314 | NA | NA | NA | 5,333 | 3,583 | 7,493 |
| 2010 | 678 | 843 | 591 | 1,144 | 4,128 | 2,478 | 6,088 | 5,130 | 3,650 | 6,776 |
| 2011 | 839 | 899 | 645 | 1,205 | 5,137 | 3,625 | 7,019 | 5,435 | 3,942 | 7,303 |
| 2012 | 1,111 | 993 | 663 | 1,415 | 6,938 | 5,266 | 8,726 | 5,975 | 4,002 | 8,526 |
| ‘I‘iwi |  |  |  |  |  |  |  |  |  |  |
| Open forest |  |  |  |  |  |  |  |  |  |  |
| 1987 | 4,590 | 5,133 | 4,416 | 6,267 | 49,485 | 45,245 | 54,666 | 56,055 | 46,680 | 68,904 |
| 1988 | 6,014 | 5,918 | 5,335 | 6,554 | 56,707 | 50,281 | 63,993 | 60,372 | 52,795 | 69,948 |
| 1989 | 7,121 | 6,561 | 5,811 | 7,297 | 80,008 | 74,712 | 85,647 | 68,037 | 59,128 | 78,998 |
| 1990 | 6,153 | 6,332 | 5,781 | 6,967 | 62,094 | 57,031 | 67,116 | 66,050 | 58,697 | 74,304 |
| 1991 | 6,406 | 6,504 | 5,942 | 7,141 | 65,187 | 60,272 | 70,263 | 68,032 | 60,559 | 76,389 |
| 1992 | 7,152 | 6,897 | 6,164 | 7,610 | 83,151 | 77,731 | 88,899 | 73,414 | 64,342 | 84,608 |
| 1993 | 7,206 | 6,982 | 6,207 | 7,759 | 72,162 | 67,538 | 77,677 | 71,286 | 63,439 | 80,413 |
| 1994 | 6,820 | 6,786 | 6,110 | 7,467 | 62,667 | 58,252 | 66,819 | 68,936 | 60,632 | 77,564 |
| 1995 | 6,897 | 6,689 | 6,072 | 7,320 | 75,640 | 71,164 | 80,959 | 72,405 | 64,480 | 81,298 |
| 1996 | 5,803 | 6,196 | 5,584 | 6,900 | 69,905 | 65,230 | 74,624 | 72,680 | 64,878 | 81,546 |
| 1997 | 6,269 | 6,371 | 5,783 | 7,006 | 78,193 | 73,386 | 83,111 | 76,075 | 67,064 | 85,734 |
| 1998 | 7,254 | 6,724 | 5,956 | 7,454 | 87,627 | 82,544 | 93,496 | 78,618 | 67,772 | 90,881 |
| 1999 | 6,113 | 6,283 | 5,731 | 6,911 | 73,073 | 68,499 | 78,078 | 75,017 | 66,536 | 84,637 |
| 2000 | 6,551 | 6,260 | 5,657 | 6,885 | 80,274 | 75,157 | 85,718 | 74,396 | 65,621 | 84,796 |
| 2001 | 5,612 | 5,782 | 5,254 | 6,368 | 67,936 | 63,682 | 72,712 | 69,694 | 62,034 | 78,383 |
| 2002 | 5,338 | 5,545 | 5,018 | 6,192 | 61,874 | 58,043 | 66,006 | 66,475 | 58,226 | 75,138 |
| 2003 | 5,375 | 5,531 | 5,027 | 6,146 | 62,957 | 58,117 | 67,922 | 66,346 | 57,996 | 74,528 |
| 2004 | 5,434 | 5,644 | 5,122 | 6,218 | 66,252 | 62,019 | 70,931 | 68,234 | 60,317 | 76,393 |
| 2005 | 6,631 | 6,148 | 5,447 | 6,806 | 79,023 | 73,983 | 85,202 | 71,739 | 63,254 | 81,022 |
| 2006 | 6,006 | 5,919 | 5,340 | 6,540 | 70,118 | 64,569 | 75,552 | 69,784 | 62,294 | 78,005 |
| 2007 | 5,408 | 5,583 | 5,075 | 6,174 | 67,264 | 62,333 | 72,297 | 67,794 | 60,261 | 76,143 |
| 2008 | 5,367 | 5,518 | 4,997 | 6,131 | 61,621 | 56,137 | 68,091 | 65,853 | 57,478 | 74,564 |
| 2009 | NA | 5,622 | 4,852 | 6,413 | NA | NA | NA | 66,945 | 56,028 | 77,684 |
| 2010 | 5,586 | 5,680 | 5,130 | 6,273 | 67,571 | 59,324 | 76,807 | 67,926 | 59,937 | 76,665 |
| 2011 | 5,993 | 5,849 | 5,258 | 6,461 | 68,381 | 60,900 | 77,039 | 68,868 | 60,615 | 77,723 |
| 2012 | 5,815 | 5,829 | 5,202 | 6,510 | 70,499 | 62,748 | 79,040 | 69,960 | 60,547 | 80,193 |
| Closed forest |  |  |  |  |  |  |  |  |  |  |
| 1999 | 5,805 | 5,684 | 4,505 | 6,963 | 41,728 | 39,105 | 44,643 | 40,448 | 33,281 | 47,553 |
| 2000 | 5,926 | 5,612 | 4,569 | 6,657 | 42,865 | 38,927 | 46,693 | 40,408 | 33,875 | 46,616 |
| 2001 | 4,763 | 5,012 | 4,199 | 6,040 | 35,115 | 31,986 | 38,346 | 36,070 | 31,182 | 41,783 |
| 2002 | 3,989 | 4,688 | 3,797 | 5,923 | 29,019 | 26,346 | 31,814 | 33,268 | 27,999 | 40,403 |
| 2003 | 5,832 | 5,506 | 4,622 | 6,511 | 38,641 | 34,202 | 43,546 | 37,700 | 32,643 | 42,953 |
| 2004 | 6,263 | 5,853 | 4,823 | 7,014 | 42,004 | 37,427 | 46,739 | 39,801 | 34,014 | 45,871 |
| 2005 | 5,429 | 5,526 | 4,686 | 6,512 | 39,093 | 34,859 | 43,339 | 38,817 | 33,618 | 44,085 |
| 2006 | 6,410 | 5,753 | 4,703 | 6,787 | 40,246 | 35,570 | 44,785 | 38,596 | 33,505 | 43,861 |
| 2007 | 4,514 | 4,898 | 4,114 | 5,946 | 33,808 | 30,765 | 36,819 | 35,327 | 30,472 | 40,929 |
| 2008 | 4,341 | 4,742 | 3,891 | 5,865 | 30,991 | 27,439 | 34,957 | 33,716 | 28,631 | 40,732 |
| 2009 | NA | 4,908 | 3,519 | 6,266 | NA | NA | NA | 35,675 | 27,542 | 43,779 |
| 2010 | 4,949 | 5,124 | 4,274 | 6,242 | 37,251 | 32,342 | 42,529 | 37,391 | 32,125 | 43,345 |
| 2011 | 5,839 | 5,633 | 4,533 | 6,690 | 37,461 | 32,803 | 42,899 | 38,262 | 32,868 | 44,599 |
| 2012 | 5,794 | 5,643 | 4,481 | 6,903 | 44,907 | 38,863 | 51,912 | 41,957 | 33,531 | 49,972 |
| ‘Apapane |  |  |  |  |  |  |  |  |  |  |
| Open forest |  |  |  |  |  |  |  |  |  |  |
| 1987 | 5,366 | 4,485 | 3,502 | 5,663 | 34,877 | 32,215 | 43,262 | 28,420 | 21,864 | 36,122 |
| 1988 | 2,709 | 4,229 | 3,200 | 5,232 | 15,780 | 14,083 | 19,971 | 26,853 | 18,227 | 33,945 |
| 1989 | 5,581 | 4,671 | 3,816 | 5,712 | 35,693 | 32,743 | 44,318 | 29,773 | 24,186 | 36,448 |
| 1990 | 4,793 | 4,823 | 3,949 | 5,913 | 30,527 | 27,865 | 38,209 | 30,756 | 25,311 | 37,171 |
| 1991 | 5,315 | 5,030 | 4,118 | 6,206 | 34,884 | 31,874 | 43,100 | 32,187 | 26,492 | 40,603 |
| 1992 | 6,797 | 5,225 | 4,188 | 6,779 | 49,242 | 46,477 | 60,215 | 34,058 | 27,230 | 48,866 |
| 1993 | 5,448 | 4,975 | 4,121 | 6,065 | 34,459 | 31,713 | 42,851 | 32,119 | 26,614 | 39,553 |
| 1994 | 4,021 | 4,632 | 3,777 | 5,554 | 23,397 | 21,341 | 29,313 | 30,140 | 23,410 | 35,999 |
| 1995 | 4,441 | 4,550 | 3,687 | 5,473 | 28,394 | 26,425 | 35,143 | 30,330 | 24,020 | 36,412 |
| 1996 | 4,091 | 4,446 | 3,554 | 5,325 | 29,138 | 27,050 | 36,054 | 30,832 | 24,697 | 36,555 |
| 1997 | 3,601 | 4,416 | 3,478 | 5,278 | 26,783 | 24,501 | 33,305 | 31,195 | 24,683 | 37,035 |
| 1998 | 4,904 | 4,661 | 3,843 | 5,563 | 34,769 | 32,019 | 42,716 | 32,769 | 27,153 | 39,209 |
| 1999 | 5,082 | 4,810 | 3,961 | 5,808 | 35,818 | 32,773 | 44,621 | 33,792 | 28,108 | 40,737 |
| 2000 | 5,020 | 4,861 | 4,037 | 5,890 | 36,678 | 34,088 | 45,434 | 34,294 | 28,440 | 41,506 |
| 2001 | 4,556 | 4,825 | 3,966 | 5,719 | 33,531 | 31,102 | 41,525 | 34,177 | 28,139 | 40,944 |
| 2002 | 4,836 | 4,890 | 4,036 | 5,821 | 34,202 | 31,647 | 42,574 | 34,286 | 28,019 | 41,024 |
| 2003 | 5,200 | 4,941 | 4,057 | 5,915 | 35,899 | 33,248 | 44,385 | 34,616 | 28,142 | 41,534 |
| 2004 | 4,167 | 4,863 | 3,926 | 5,803 | 29,517 | 27,215 | 36,648 | 34,167 | 27,224 | 40,853 |
| 2005 | 4,988 | 5,023 | 4,086 | 6,004 | 32,600 | 29,752 | 40,662 | 34,863 | 27,726 | 41,514 |
| 2006 | 5,128 | 5,144 | 4,176 | 6,137 | 34,631 | 31,784 | 42,770 | 35,936 | 28,953 | 42,813 |
| 2007 | 4,101 | 5,215 | 4,116 | 6,290 | 30,010 | 27,846 | 37,349 | 36,735 | 29,377 | 44,314 |
| 2008 | 6,627 | 5,749 | 4,676 | 7,054 | 45,441 | 42,243 | 56,167 | 39,712 | 32,372 | 48,845 |
| 2009 | NA | 6,008 | 4,771 | 7,781 | NA | NA | NA | 41,058 | 32,307 | 54,221 |
| 2010 | 6,757 | 6,235 | 5,034 | 7,746 | 46,891 | 42,766 | 58,643 | 42,565 | 34,274 | 53,586 |
| 2011 | 5,951 | 6,337 | 5,079 | 7,952 | 41,053 | 37,184 | 51,408 | 43,064 | 34,606 | 54,266 |
| 2012 | 7,500 | 6,673 | 5,165 | 8,687 | 49,276 | 45,212 | 61,173 | 44,974 | 34,635 | 59,078 |
| Closed forest |  |  |  |  |  |  |  |  |  |  |
| 1999 | 5,593 | 5,115 | 4,164 | 6,013 | 23,676 | 21,836 | 29,642 | 22,092 | 17,162 | 26,679 |
| 2000 | 4,315 | 4,697 | 4,078 | 5,512 | 18,394 | 16,566 | 23,039 | 19,736 | 16,613 | 23,543 |
| 2001 | 5,118 | 4,963 | 4,282 | 5,699 | 22,364 | 20,567 | 27,878 | 21,400 | 17,794 | 24,992 |
| 2002 | 5,053 | 4,983 | 4,328 | 5,695 | 21,558 | 19,789 | 26,847 | 20,840 | 17,386 | 24,492 |
| 2003 | 5,074 | 4,936 | 4,293 | 5,605 | 18,665 | 16,993 | 23,341 | 18,987 | 16,090 | 22,447 |
| 2004 | 4,168 | 4,633 | 3,955 | 5,431 | 15,250 | 13,630 | 19,181 | 17,396 | 14,395 | 21,934 |
| 2005 | 5,032 | 4,960 | 4,320 | 5,684 | 21,445 | 19,509 | 27,001 | 20,449 | 17,243 | 24,065 |
| 2006 | 4,934 | 5,047 | 4,372 | 5,799 | 19,452 | 17,717 | 24,342 | 20,210 | 17,143 | 23,904 |
| 2007 | 4,986 | 5,202 | 4,511 | 6,035 | 21,680 | 19,765 | 27,287 | 21,922 | 18,538 | 25,806 |
| 2008 | 5,753 | 5,588 | 4,805 | 6,450 | 23,684 | 21,131 | 29,932 | 23,326 | 19,553 | 27,571 |
| 2009 | NA | 5,689 | 4,540 | 6,893 | NA | NA | NA | 23,949 | 17,800 | 31,484 |
| 2010 | 5,220 | 5,745 | 4,888 | 6,812 | 22,973 | 19,912 | 29,131 | 24,392 | 20,512 | 29,510 |
| 2011 | 6,629 | 6,535 | 5,552 | 7,567 | 27,453 | 25,359 | 34,250 | 27,735 | 23,162 | 32,827 |
| 2012 | 8,000 | 7,356 | 5,820 | 8,764 | 35,413 | 32,889 | 43,802 | 32,837 | 25,033 | 39,460 |
| Red-billed Leiothrix | |  |  |  |  |  |  |  |  |  |
| Open forest |  |  |  |  |  |  |  |  |  |  |
| 1987 | 1,659 | 1,690 | 1,321 | 2,141 | 10,494 | 8,110 | 12,657 | 10,143 | 8,064 | 12,708 |
| 1988 | 2,122 | 1,785 | 1,375 | 2,272 | 11,035 | 8,624 | 13,512 | 10,285 | 8,324 | 12,669 |
| 1989 | 2,020 | 1,685 | 1,348 | 2,101 | 13,379 | 10,260 | 16,386 | 10,313 | 8,438 | 12,895 |
| 1990 | 1,089 | 1,409 | 1,094 | 1,745 | 7,279 | 5,607 | 8,849 | 9,383 | 7,464 | 11,129 |
| 1991 | 1,259 | 1,403 | 1,115 | 1,712 | 7,967 | 6,068 | 9,766 | 9,329 | 7,425 | 11,109 |
| 1992 | 1,452 | 1,458 | 1,184 | 1,746 | 10,104 | 7,840 | 11,987 | 9,661 | 7,949 | 11,297 |
| 1993 | 1,381 | 1,469 | 1,191 | 1,762 | 9,156 | 7,081 | 11,208 | 9,637 | 7,837 | 11,338 |
| 1994 | 1,459 | 1,527 | 1,242 | 1,823 | 7,893 | 6,009 | 9,596 | 9,652 | 7,683 | 11,391 |
| 1995 | 1,764 | 1,628 | 1,342 | 1,963 | 10,758 | 8,453 | 13,030 | 10,274 | 8,627 | 12,019 |
| 1996 | 1,798 | 1,640 | 1,347 | 1,964 | 12,257 | 9,628 | 14,741 | 10,683 | 8,967 | 12,711 |
| 1997 | 1,368 | 1,536 | 1,249 | 1,844 | 9,758 | 7,837 | 11,567 | 10,497 | 8,628 | 12,296 |
| 1998 | 1,421 | 1,543 | 1,242 | 1,861 | 8,900 | 7,168 | 10,647 | 10,511 | 8,490 | 12,226 |
| 1999 | 1,544 | 1,603 | 1,301 | 1,913 | 10,954 | 8,482 | 13,563 | 11,059 | 9,124 | 13,005 |
| 2000 | 1,384 | 1,664 | 1,333 | 2,008 | 9,628 | 7,596 | 11,283 | 11,475 | 9,567 | 13,569 |
| 2001 | 2,439 | 1,998 | 1,610 | 2,510 | 16,757 | 13,762 | 19,440 | 12,851 | 10,695 | 16,459 |
| 2002 | 2,456 | 2,080 | 1,647 | 2,649 | 15,783 | 13,095 | 18,024 | 13,200 | 10,885 | 16,880 |
| 2003 | 1,970 | 1,986 | 1,638 | 2,428 | 12,977 | 10,424 | 15,074 | 12,933 | 10,885 | 15,979 |
| 2004 | 2,136 | 1,952 | 1,620 | 2,381 | 15,041 | 12,465 | 17,227 | 12,931 | 10,852 | 15,814 |
| 2005 | 1,530 | 1,798 | 1,466 | 2,157 | 10,163 | 8,137 | 11,912 | 12,299 | 10,114 | 14,510 |
| 2006 | 2,177 | 1,882 | 1,553 | 2,271 | 14,612 | 12,124 | 16,651 | 12,701 | 10,704 | 15,101 |
| 2007 | 1,467 | 1,734 | 1,373 | 2,105 | 10,555 | 8,579 | 12,185 | 12,296 | 10,070 | 14,642 |
| 2008 | 1,785 | 1,788 | 1,451 | 2,160 | 12,647 | 10,350 | 14,868 | 12,548 | 10,318 | 14,922 |
| 2009 | NA | 1,804 | 1,349 | 2,303 | NA | NA | NA | 12,643 | 9,922 | 15,440 |
| 2010 | 1,664 | 1,815 | 1,455 | 2,236 | 11,593 | 9,190 | 13,650 | 12,703 | 10,312 | 15,284 |
| 2011 | 1,944 | 1,932 | 1,566 | 2,362 | 12,886 | 10,273 | 15,306 | 13,087 | 10,650 | 15,855 |
| 2012 | 2,154 | 2,029 | 1,574 | 2,539 | 14,319 | 11,627 | 16,636 | 13,569 | 10,754 | 16,796 |
| Closed forest |  |  |  |  |  |  |  |  |  |  |
| 1999 | 1,788 | 1,836 | 1,358 | 2,487 | 6,662 | 5,260 | 7,831 | 7,111 | 5,438 | 9,408 |
| 2000 | 1,500 | 1,741 | 1,337 | 2,373 | 6,257 | 4,986 | 7,545 | 7,113 | 5,571 | 9,142 |
| 2001 | 2,043 | 2,016 | 1,576 | 2,540 | 8,387 | 6,656 | 9,872 | 8,001 | 6,353 | 9,862 |
| 2002 | 2,298 | 2,199 | 1,699 | 2,725 | 9,311 | 7,359 | 11,043 | 8,509 | 6,724 | 10,501 |
| 2003 | 2,295 | 2,243 | 1,757 | 2,781 | 7,877 | 6,221 | 9,372 | 8,175 | 6,614 | 10,030 |
| 2004 | 2,368 | 2,268 | 1,769 | 2,862 | 8,688 | 6,910 | 10,353 | 8,404 | 6,814 | 10,433 |
| 2005 | 2,254 | 2,233 | 1,742 | 2,799 | 8,350 | 6,312 | 10,201 | 8,353 | 6,739 | 10,337 |
| 2006 | 2,541 | 2,233 | 1,693 | 2,852 | 10,408 | 8,307 | 12,577 | 8,774 | 6,800 | 11,210 |
| 2007 | 1,622 | 1,812 | 1,428 | 2,329 | 6,680 | 5,277 | 7,743 | 7,496 | 5,984 | 9,311 |
| 2008 | 1,941 | 1,818 | 1,394 | 2,291 | 8,376 | 6,495 | 9,853 | 7,601 | 5,988 | 9,342 |
| 2009 | NA | 1,591 | 1,082 | 2,201 | NA | NA | NA | 6,804 | 4,768 | 8,969 |
| 2010 | 1,085 | 1,371 | 1,030 | 1,896 | 4,766 | 3,320 | 6,230 | 5,999 | 4,441 | 7,992 |
| 2011 | 1,806 | 1,625 | 1,222 | 2,046 | 6,803 | 4,989 | 8,689 | 6,555 | 5,130 | 8,214 |
| 2012 | 1,492 | 1,538 | 1,148 | 2,053 | 6,623 | 5,012 | 8,027 | 6,620 | 5,069 | 8,562 |
| Japanese White-eye | |  |  |  |  |  |  |  |  |  |
| Open forest |  |  |  |  |  |  |  |  |  |  |
| 1987 | 1,288 | 1,116 | 768 | 1,489 | 14,494 | 12,884 | 19,270 | 11,859 | 8,016 | 16,522 |
| 1988 | 953 | 997 | 753 | 1,291 | 9,771 | 8,441 | 13,294 | 10,582 | 8,079 | 13,827 |
| 1989 | 1,020 | 968 | 749 | 1,235 | 11,334 | 9,987 | 15,314 | 10,580 | 8,138 | 13,497 |
| 1990 | 793 | 878 | 683 | 1,129 | 9,017 | 7,767 | 12,389 | 9,754 | 7,616 | 12,495 |
| 1991 | 838 | 881 | 688 | 1,120 | 8,146 | 7,051 | 11,149 | 9,527 | 7,319 | 12,279 |
| 1992 | 964 | 922 | 715 | 1,153 | 11,837 | 10,320 | 15,970 | 10,540 | 8,119 | 13,375 |
| 1993 | 1,160 | 940 | 716 | 1,216 | 13,183 | 11,781 | 17,669 | 10,728 | 8,180 | 13,975 |
| 1994 | 541 | 737 | 535 | 990 | 6,204 | 5,146 | 8,942 | 8,763 | 6,085 | 11,633 |
| 1995 | 723 | 795 | 621 | 1,016 | 8,229 | 7,020 | 11,524 | 9,389 | 7,150 | 11,957 |
| 1996 | 1,187 | 933 | 698 | 1,235 | 14,310 | 12,906 | 19,120 | 11,025 | 8,333 | 14,564 |
| 1997 | 731 | 803 | 617 | 1,034 | 9,159 | 7,907 | 12,598 | 9,909 | 7,512 | 12,684 |
| 1998 | 655 | 764 | 568 | 1,024 | 7,573 | 6,381 | 10,622 | 9,420 | 6,810 | 12,776 |
| 1999 | 636 | 801 | 578 | 1,078 | 7,908 | 6,659 | 11,206 | 10,027 | 7,120 | 13,422 |
| 2000 | 1,076 | 1,024 | 796 | 1,282 | 13,424 | 12,177 | 17,889 | 12,527 | 9,648 | 15,862 |
| 2001 | 1,495 | 1,235 | 918 | 1,626 | 18,166 | 16,531 | 23,707 | 14,771 | 11,058 | 19,673 |
| 2002 | 1,241 | 1,216 | 942 | 1,548 | 15,045 | 13,361 | 19,918 | 14,592 | 11,260 | 18,476 |
| 2003 | 1,200 | 1,196 | 931 | 1,525 | 14,355 | 12,895 | 18,836 | 14,360 | 11,128 | 18,212 |
| 2004 | 1,005 | 1,157 | 892 | 1,487 | 11,967 | 10,702 | 15,802 | 13,952 | 10,543 | 17,807 |
| 2005 | 1,298 | 1,282 | 995 | 1,615 | 15,821 | 14,369 | 21,020 | 15,397 | 11,958 | 19,467 |
| 2006 | 1,274 | 1,348 | 1,041 | 1,716 | 14,754 | 13,530 | 19,427 | 15,995 | 12,407 | 20,323 |
| 2007 | 1,420 | 1,494 | 1,166 | 1,892 | 17,285 | 15,727 | 22,420 | 17,667 | 13,775 | 22,341 |
| 2008 | 1,835 | 1,727 | 1,314 | 2,238 | 21,345 | 18,999 | 28,208 | 19,916 | 15,150 | 25,624 |
| 2009 | NA | 1,905 | 1,334 | 2,771 | NA | NA | NA | 21,665 | 15,403 | 31,670 |
| 2010 | 2,507 | 2,084 | 1,479 | 2,752 | 28,567 | 26,503 | 36,985 | 23,378 | 16,824 | 31,940 |
| 2011 | 1,824 | 1,899 | 1,444 | 2,447 | 20,572 | 18,192 | 27,502 | 21,565 | 16,305 | 28,094 |
| 2012 | 1,722 | 1,844 | 1,365 | 2,468 | 19,734 | 17,184 | 27,053 | 21,259 | 15,434 | 28,827 |
| Closed forest |  |  |  |  |  |  |  |  |  |  |
| 1999 | 743 | 728 | 539 | 975 | 5,455 | 4,559 | 7,682 | 5,322 | 3,988 | 7,010 |
| 2000 | 676 | 738 | 561 | 947 | 5,020 | 4,066 | 7,186 | 5,383 | 4,178 | 6,922 |
| 2001 | 731 | 783 | 604 | 982 | 5,350 | 4,248 | 7,852 | 5,754 | 4,529 | 7,127 |
| 2002 | 915 | 877 | 692 | 1,116 | 6,794 | 5,674 | 9,554 | 6,424 | 5,157 | 8,170 |
| 2003 | 1,221 | 982 | 750 | 1,303 | 8,755 | 7,202 | 12,507 | 7,068 | 5,513 | 9,378 |
| 2004 | 905 | 922 | 730 | 1,146 | 6,332 | 5,358 | 9,160 | 6,637 | 5,262 | 8,129 |
| 2005 | 683 | 880 | 639 | 1,127 | 4,951 | 3,771 | 7,338 | 6,388 | 4,626 | 8,033 |
| 2006 | 951 | 987 | 769 | 1,235 | 6,939 | 5,575 | 10,101 | 7,226 | 5,761 | 8,867 |
| 2007 | 1,365 | 1,126 | 873 | 1,441 | 10,036 | 8,919 | 13,683 | 8,248 | 6,554 | 10,606 |
| 2008 | 906 | 1,076 | 831 | 1,357 | 6,640 | 5,150 | 9,722 | 7,888 | 6,062 | 10,028 |
| 2009 | NA | 1,202 | 843 | 1,655 | NA | NA | NA | 8,881 | 6,444 | 12,142 |
| 2010 | 1,508 | 1,334 | 1,015 | 1,734 | 10,951 | 8,828 | 16,000 | 9,752 | 7,422 | 12,602 |
| 2011 | 1,468 | 1,360 | 1,036 | 1,771 | 10,900 | 9,271 | 15,090 | 10,014 | 7,609 | 12,794 |
| 2012 | 1,127 | 1,305 | 945 | 1,765 | 8,369 | 6,750 | 11,771 | 9,638 | 7,055 | 13,043 |

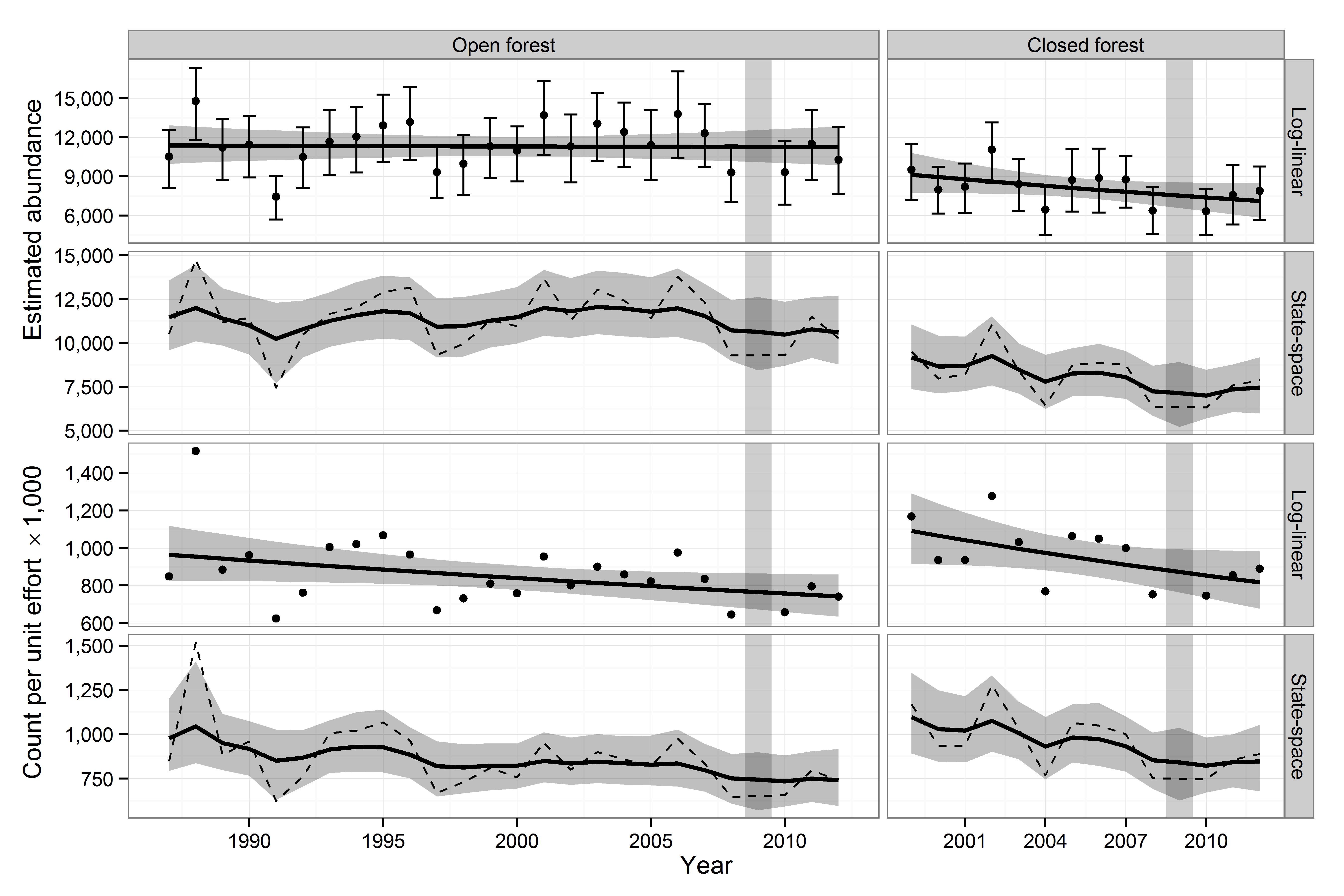
Hawai‘i ‘Elepaio

Figure S2. Trend with 95% Confidence band around a log-linear fit, and credible band around a state-space fit for forest birds at Hakalau Forest National Wildlife Refuge, Hawai‘i. The top two rows are fit to detection-corrected abundance estimates, the lower two rows are fit to the uncorrected count index. Dots are the detection-corrected abundances estimated by DISTANCE, with bootstrap uncertainties around the estimates. The same estimates are represented by the dotted line in the state-space panel. Notice how the uncertainty of the state-space fit increases in 2009, the missing year in the series indicated with a vertical grey bar.

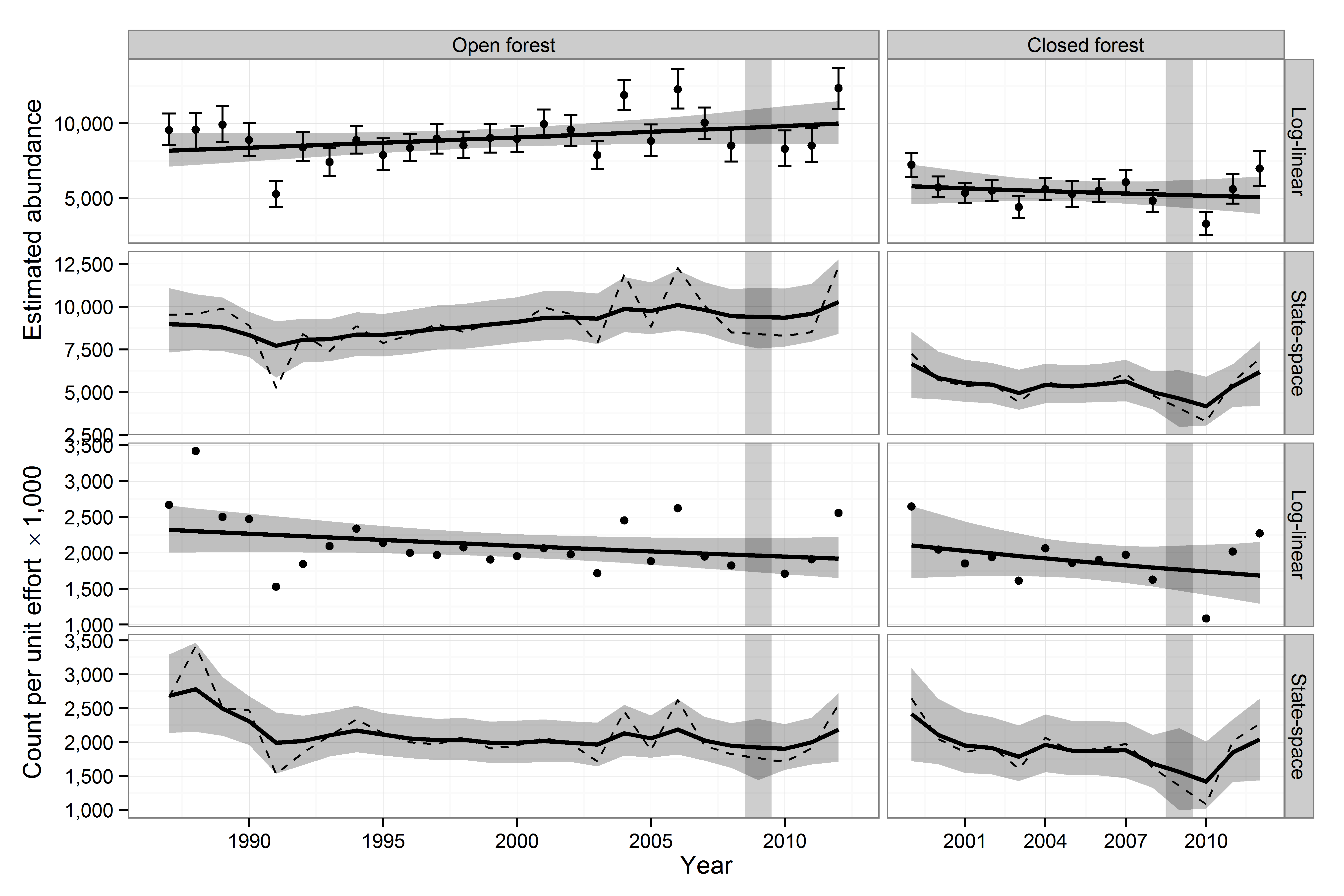
‘Ōma‘o

Figure S2. Continued.

Hawai‘i ‘Amakihi

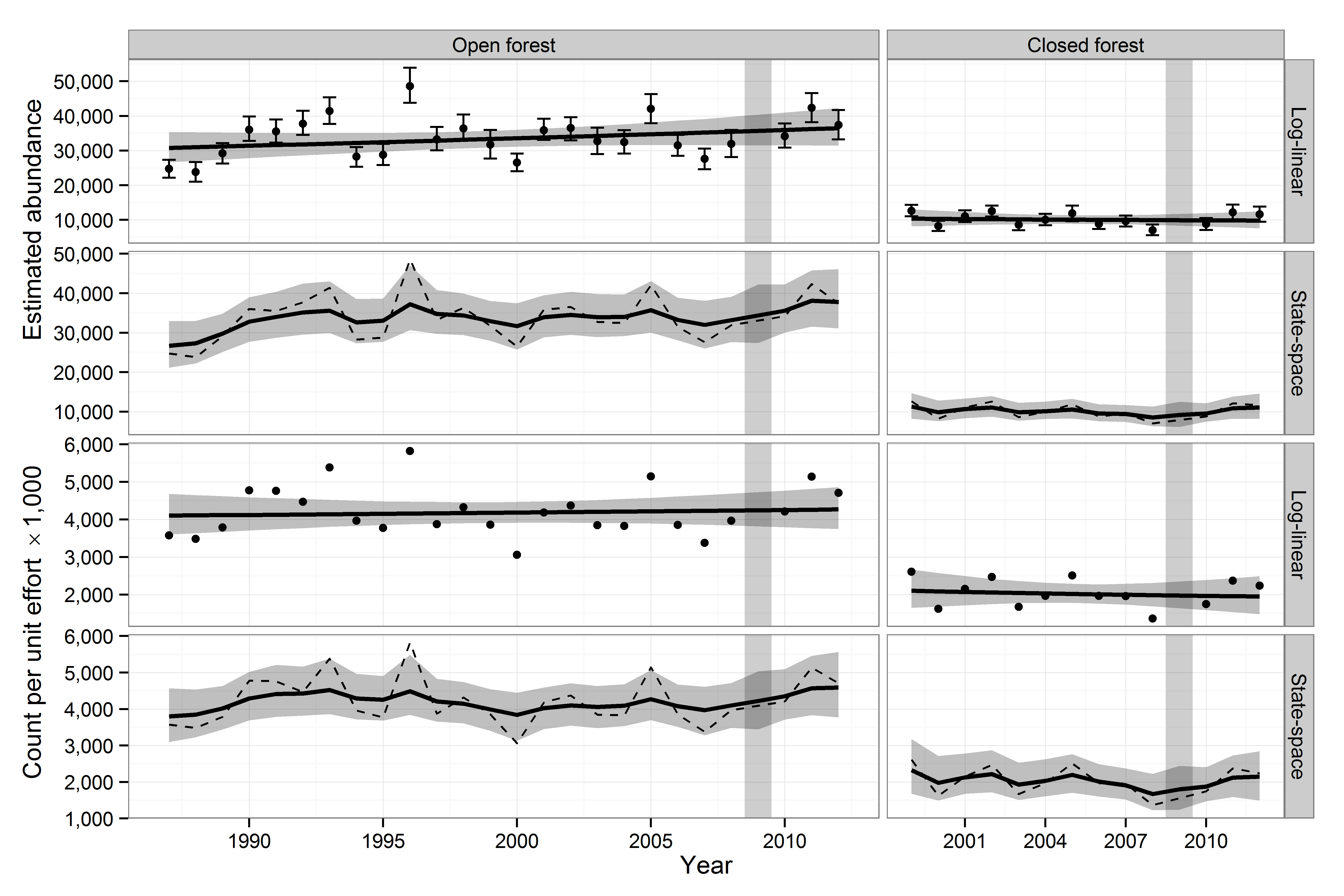


Figure S2. Continued.

‘Akiapōlā‘au

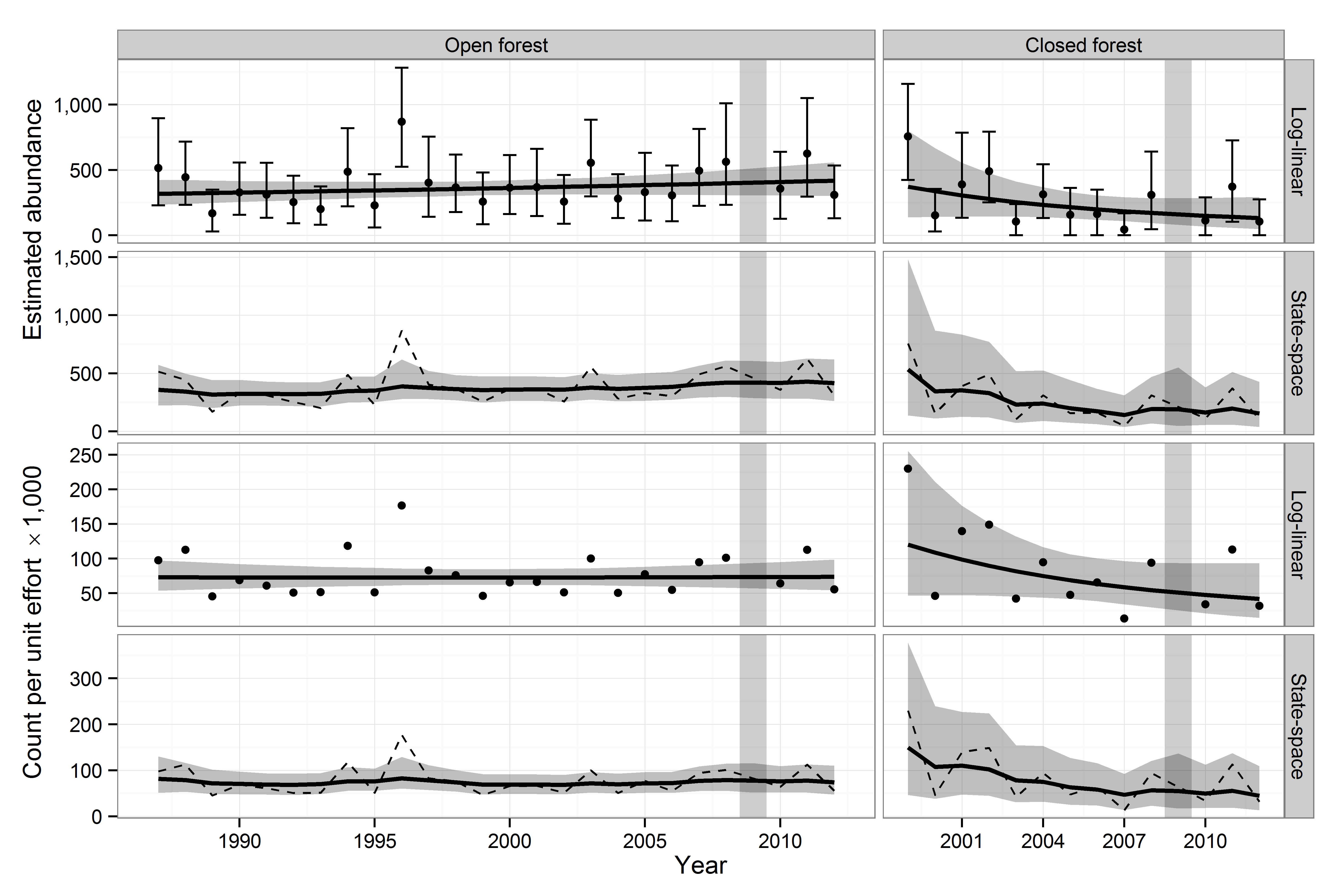


Figure S2. Continued.

Hawai‘i Creeper

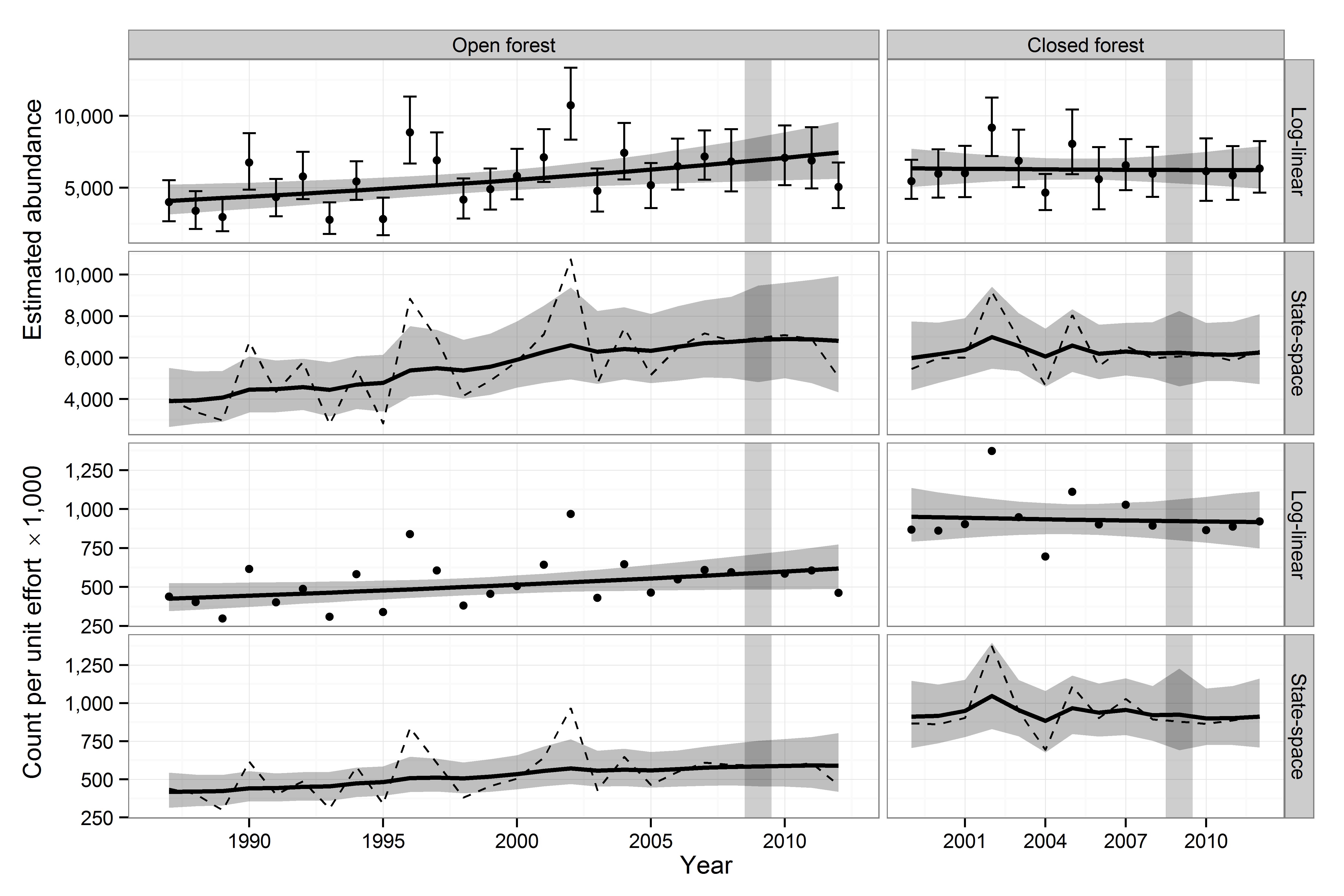


Figure S2. Continued.

Hawai‘i ‘Ākepa

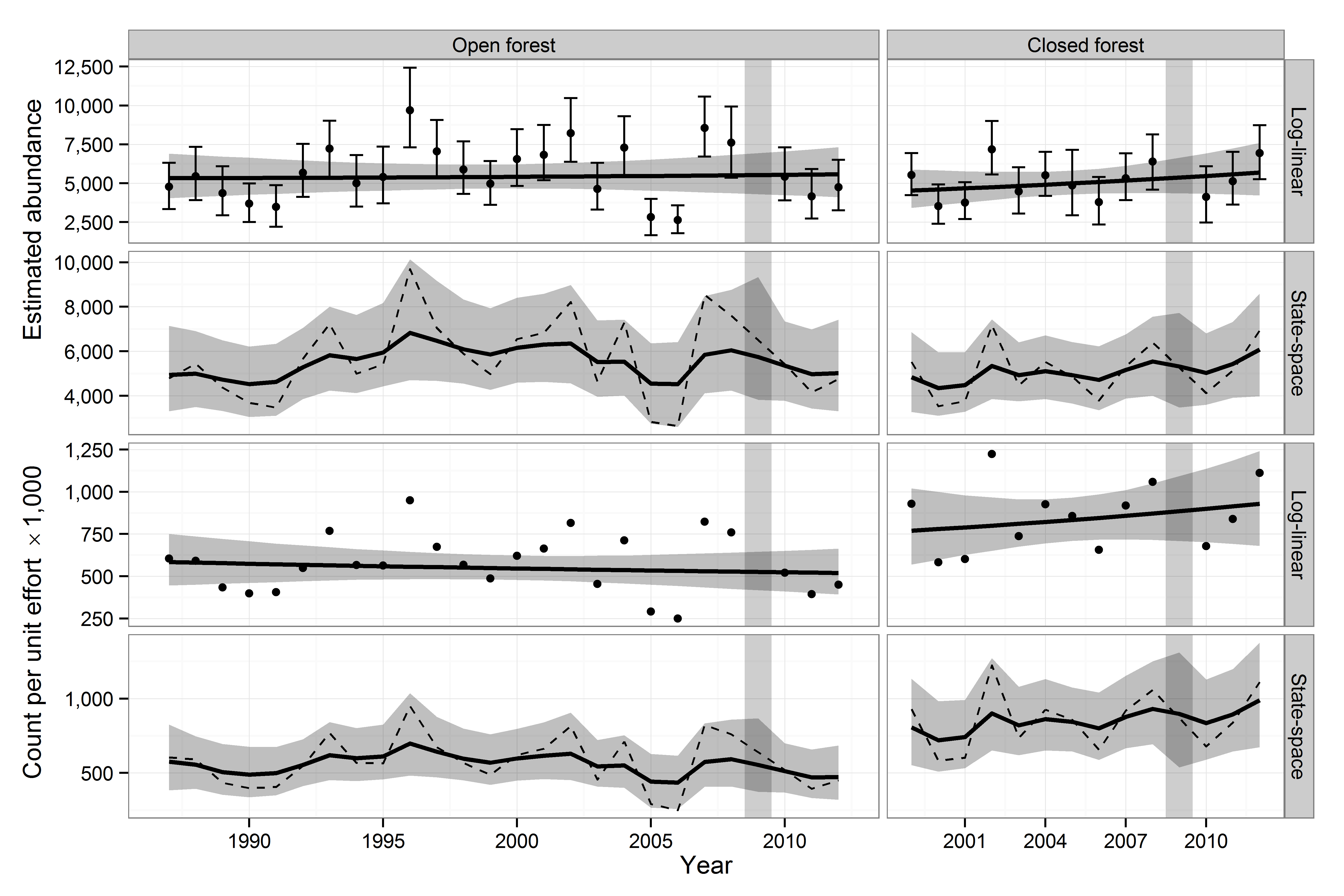


Figure S2. Continued.

‘I‘iwi

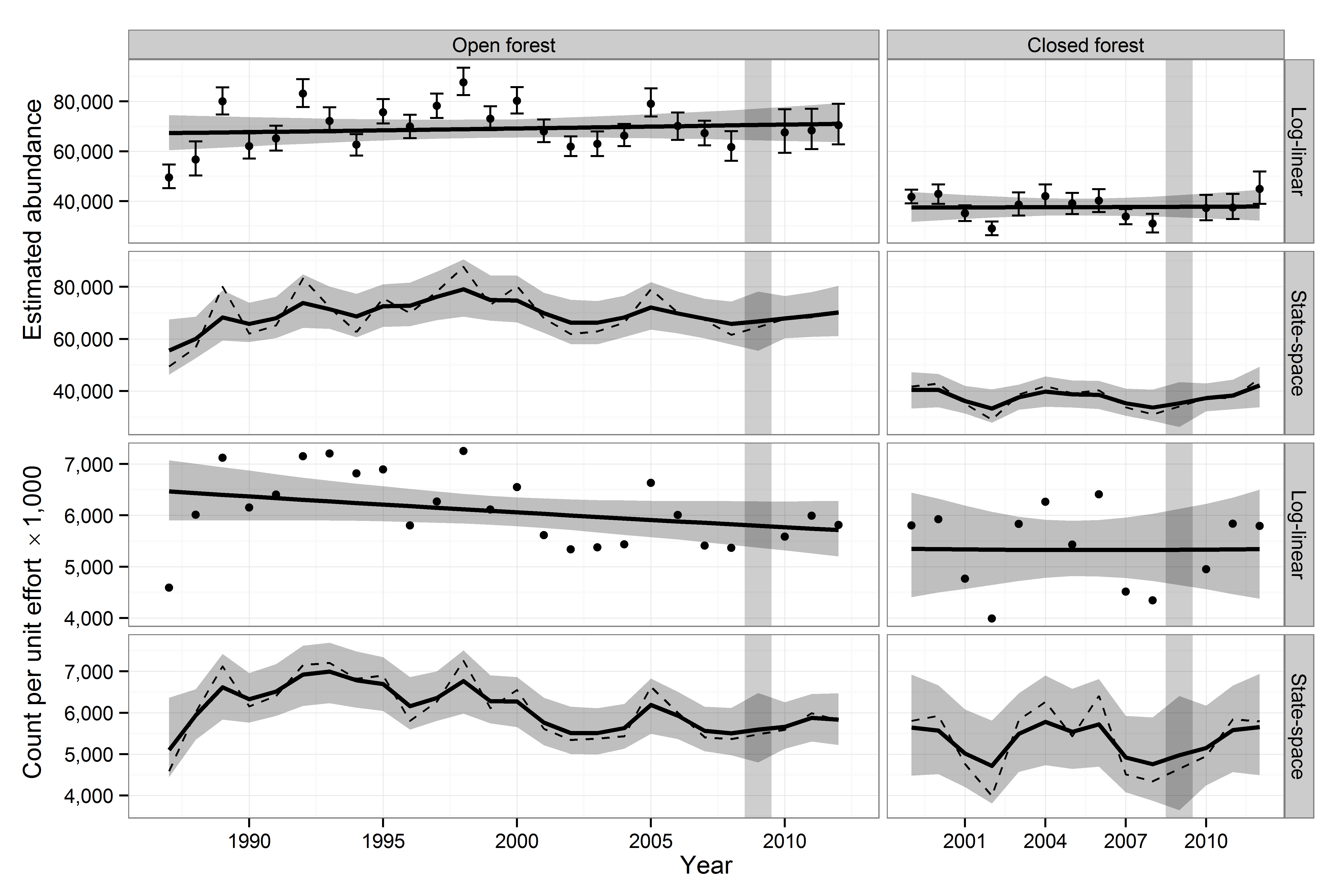


Figure S2. Continued.

‘Apapane

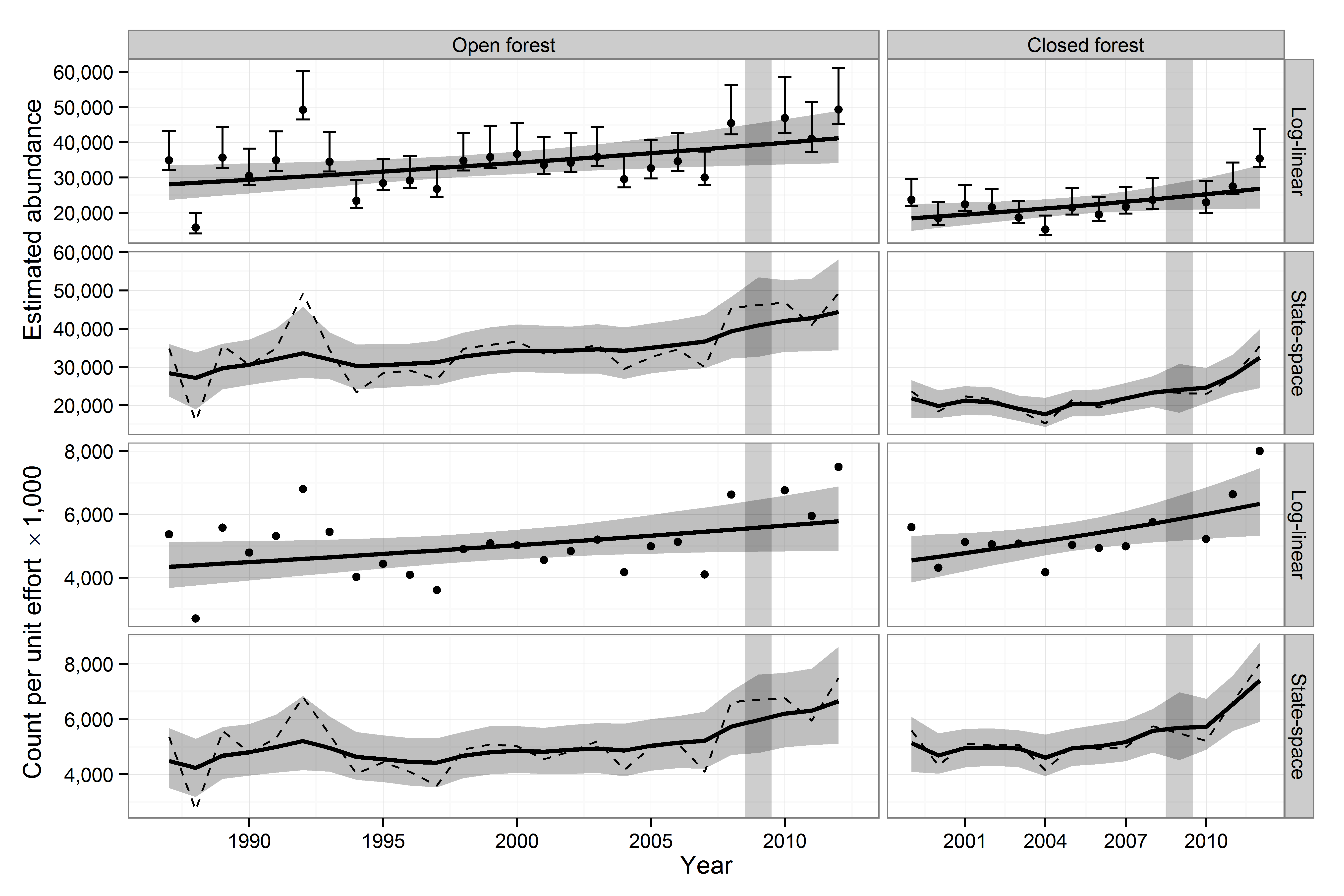


Figure S2. Continued.

Red-billed Leiothrix

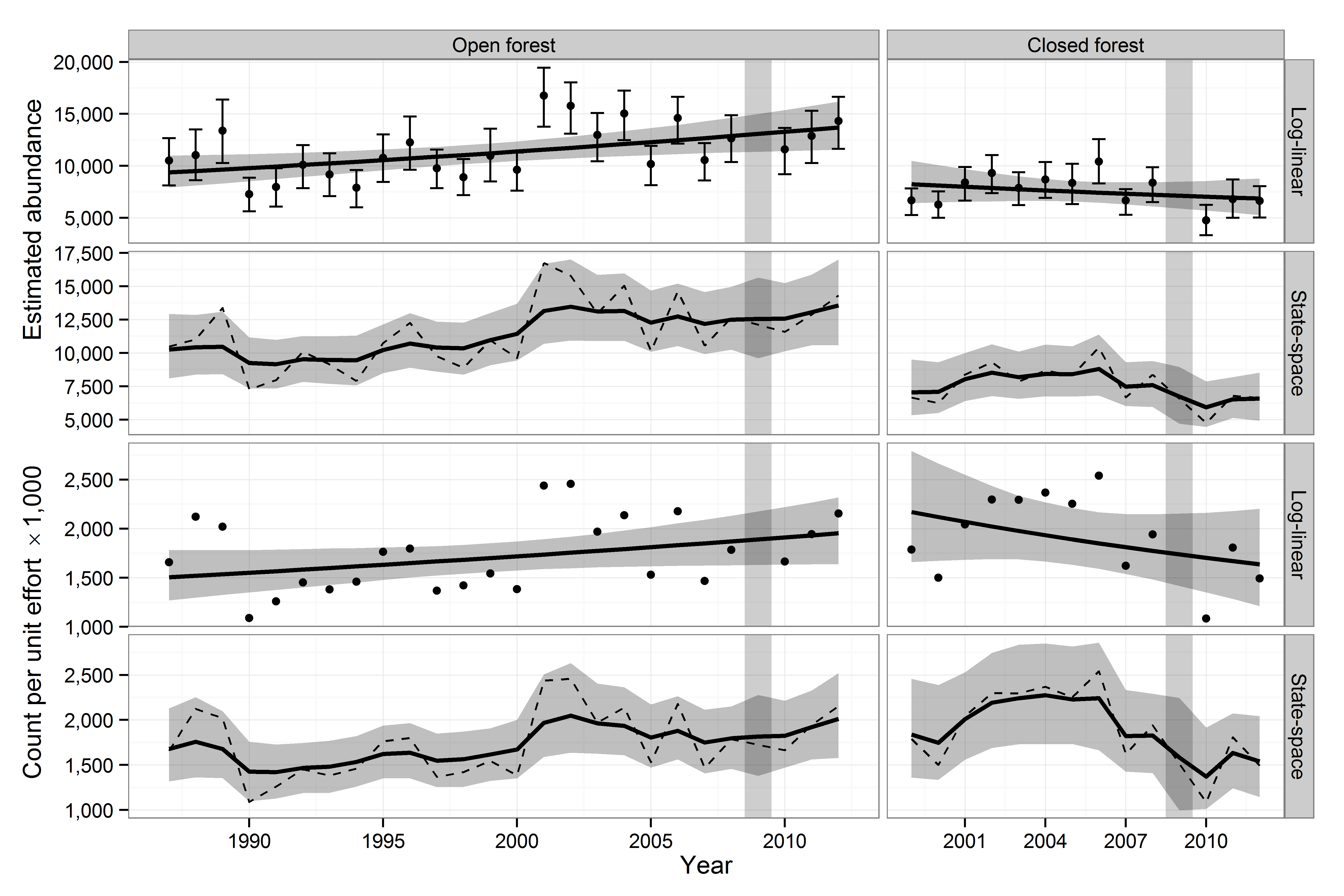


Figure S2. Continued.

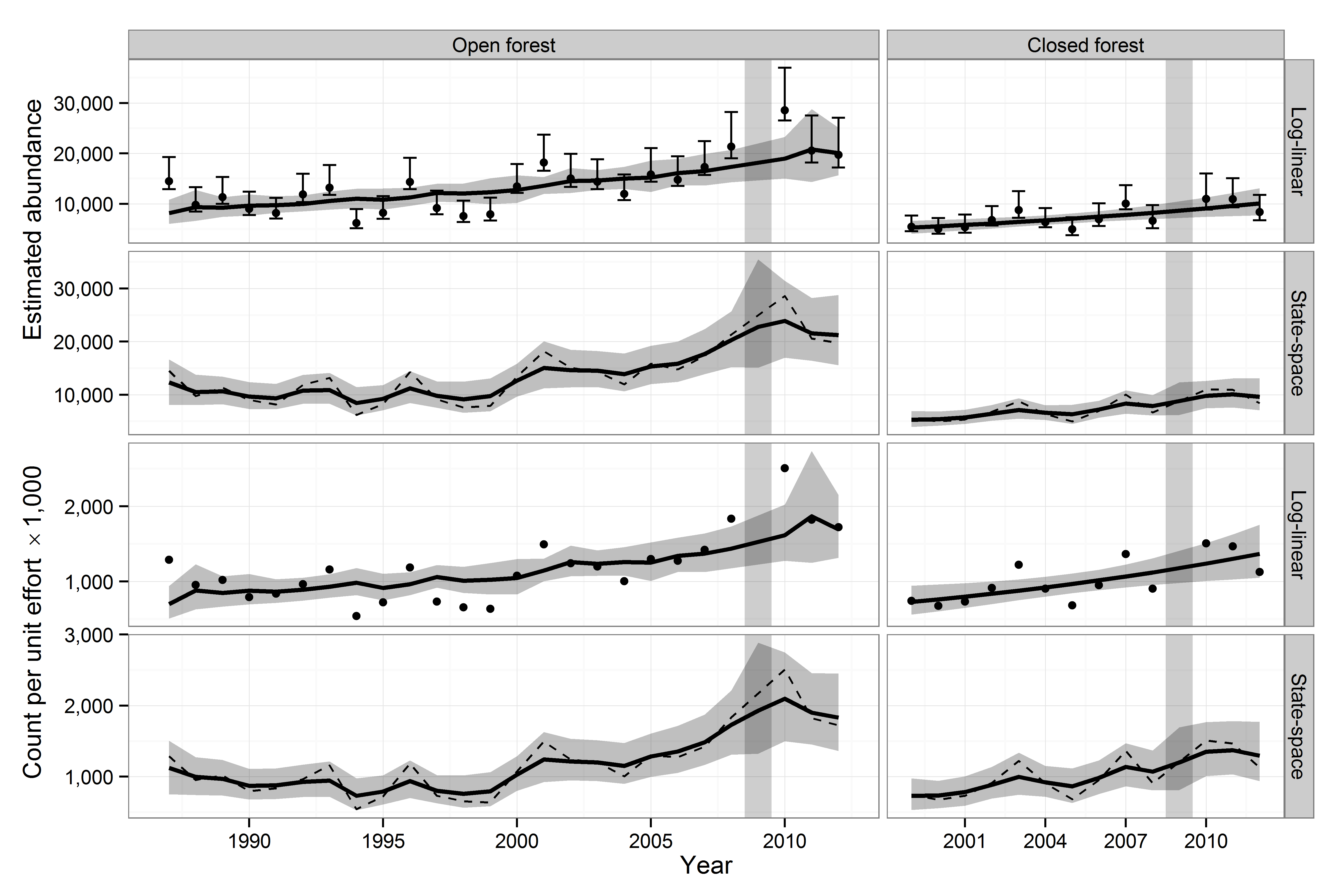
Japanese White-eye

Figure S2. Continued.

Table S5. Geometric mean, minimum and maximum population size changes (lambda) from one year to the next for both the uncorrected counts and detection-corrected abundance (Distance) estimates derived from variance non-partitioned log-linear regression and their corresponding state-space corrected population estimates.

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | Open forest | | | | |  | Closed forest | | | | |
|  |  | Non-partitioned | |  | State-space | |  | Non-partitioned | |  | State-space | |
| Species |  | Count | Distance |  | Count | Distance |  | Count | Distance |  | Count | Distance |
| Hawai‘i ‘Elepaio | Geometric mean | 0.99 | 1.00 |  | 0.99 | 1.00 |  | 0.98 | 0.98 |  | 0.98 | 0.98 |
|  | Maximum | 1.79 | 1.41 |  | 1.05 | 1.04 |  | 1.38 | 1.35 |  | 1.13 | 1.07 |
|  | Minimum | 0.58 | 0.65 |  | 0.93 | 0.94 |  | 0.74 | 0.73 |  | 0.87 | 0.89 |
| ‘Ōma‘o | Geometric mean | 1.00 | 1.01 |  | 0.99 | 1.01 |  | 1.02 | 1.03 |  | 1.00 | 1.01 |
|  | Maximum | 1.43 | 1.59 |  | 1.10 | 1.08 |  | 1.86 | 1.71 |  | 1.30 | 1.23 |
|  | Minimum | 0.62 | 0.59 |  | 0.86 | 0.92 |  | 0.77 | 0.79 |  | 0.87 | 0.89 |
| Hawai‘i ‘Amakihi | Geometric mean | 1.01 | 1.02 |  | 1.01 | 1.01 |  | 0.96 | 0.97 |  | 0.99 | 0.99 |
|  | Maximum | 1.54 | 1.69 |  | 1.07 | 1.12 |  | 1.36 | 1.38 |  | 1.10 | 1.12 |
|  | Minimum | 0.67 | 0.68 |  | 0.94 | 0.93 |  | 0.62 | 0.65 |  | 0.88 | 0.90 |
| ‘Akiapōlā‘au | Geometric mean | 1.00 | 1.00 |  | 1.00 | 1.01 |  | 0.92 | 0.92 |  | 0.91 | 0.91 |
|  | Maximum | 3.47 | 3.81 |  | 1.07 | 1.11 |  | 6.71 | 7.05 |  | 1.28 | 1.47 |
|  | Minimum | 0.40 | 0.38 |  | 0.93 | 0.92 |  | 0.20 | 0.20 |  | 0.68 | 0.61 |
| Hawai‘i Creeper | Geometric mean | 1.00 | 1.01 |  | 1.01 | 1.02 |  | 1.01 | 1.01 |  | 1.00 | 1.00 |
|  | Maximum | 2.48 | 3.13 |  | 1.07 | 1.10 |  | 1.60 | 1.73 |  | 1.10 | 1.09 |
|  | Minimum | 0.44 | 0.44 |  | 0.97 | 0.97 |  | 0.69 | 0.68 |  | 0.92 | 0.92 |
| Hawai‘i ‘Ākepa | Geometric mean | 1.00 | 1.01 |  | 1.00 | 1.01 |  | 1.06 | 1.06 |  | 1.03 | 1.03 |
|  | Maximum | 3.29 | 3.24 |  | 1.29 | 1.28 |  | 2.03 | 1.91 |  | 1.18 | 1.15 |
|  | Minimum | 0.41 | 0.39 |  | 0.82 | 0.82 |  | 0.60 | 0.62 |  | 0.91 | 0.92 |
| ‘I‘iwi | Geometric mean | 1.01 | 1.01 |  | 1.00 | 1.01 |  | 0.99 | 0.99 |  | 0.99 | 0.99 |
|  | Maximum | 1.31 | 1.41 |  | 1.15 | 1.13 |  | 1.46 | 1.33 |  | 1.17 | 1.13 |
|  | Minimum | 0.84 | 0.78 |  | 0.92 | 0.94 |  | 0.70 | 0.82 |  | 0.85 | 0.89 |
| ‘Apapane | Geometric mean | 1.01 | 1.01 |  | 1.01 | 0.98 |  | 1.04 | 1.04 |  | 1.03 | 1.03 |
|  | Maximum | 2.06 | 2.26 |  | 1.10 | 1.07 |  | 1.27 | 1.41 |  | 1.14 | 1.18 |
|  | Minimum | 0.50 | 0.45 |  | 0.93 | 0.90 |  | 0.77 | 0.78 |  | 0.92 | 0.89 |
| Red-billed Leiothrix | Geometric mean | 1.01 | 1.02 |  | 1.01 | 1.01 |  | 1.04 | 1.05 |  | 1.01 | 1.02 |
|  | Maximum | 1.76 | 1.74 |  | 1.20 | 1.12 |  | 1.66 | 1.43 |  | 1.19 | 1.12 |
|  | Minimum | 0.54 | 0.54 |  | 0.84 | 0.91 |  | 0.64 | 0.64 |  | 0.81 | 0.85 |
| Japanese White-eye | Geometric mean | 1.00 | 1.00 |  | 1.01 | 1.02 |  | 0.99 | 0.99 |  | 1.03 | 1.04 |
|  | Maximum | 1.69 | 1.74 |  | 1.28 | 1.25 |  | 1.44 | 1.45 |  | 1.14 | 1.14 |
|  | Minimum | 0.47 | 0.47 |  | 0.78 | 0.82 |  | 0.66 | 0.66 |  | 0.94 | 0.94 |