Streaked horned lark abundance and trends for the Puget Lowlands

And the lower Columbia River/Washington Coast, 2010-2023

Research Progress Report

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INTRODUCTION

The streaked horned lark (*Eremophila alpestris strigata*) is a partially migratory subspecies associated with sparsely vegetated grassland habitats (Beason 1995, Stinson 2005, Altman 2011) and is listed as threatened under the Endangered Species Act. It is also listed as endangered by the state of Washington and in Canada (Canadian Species at Risk Act 2002). The breeding range of streaked horned lark has contracted over time, with local extirpation from the northern (Puget trough, southern British Columbia, and the Washington Coast north of Grays Harbor) and southern (Rogue River Valley of Oregon) extremes of their range (Beauchesne and Cooper 2003, Stinson 2005, Altman 2011). The current breeding range includes agricultural habitats and grasslands of the Willamette Valley of Oregon, dredge deposition islands along the lower Columbia River, southern Washington coastal dune habitats, and grasslands in the Puget lowlands near Olympia and Tacoma, Washington.

Estimates of survival and fecundity from the mid-2000s indicated streaked horned lark populations in Washington were declining rapidly (Camfield et al. 2011). To provide more up to date population assessments, we developed a monitoring strategy (Pearson et al. 2015) detailing protocols for transect based monitoring that we have been implementing since 2010 on permanently occupied sites. Here we assess abundance and trends using this protocol in two geographic strata (1) Puget Sound region (sites in Pierce, Thurston, and Mason counties), and (2) Lower Columbia River (mostly Oregon sites) and the Washington coast using an analytic method that addresses issues of detectability. The goal of this monitoring effort is to assess changes in abundance and trend of this rare and declining subspecies and to provide critical information for making informed management decisions.

METHODS AND ANALYTICAL APPROACH

Lark surveys of occupied sites along the lower Columbia River, Washington coast, and southern Puget Lowlands, were conducted from 2010-2023 (Table 1) generally following the protocol of Pearson et al. (2015). All sites were visited 1-8 times per season (April 20 – July 9) and all larks detected were categorized as male, female, unknown, or young-of-the-year. In addition, observers recorded how they first detected the bird, did they see or hear it. We broadened the recommend survey window in Pearson (2015) of 1 May – 30 June to 20 April – 9 July to be more inclusive of surveys at some sites. Nine sites are included “Puget" Sound region and 22 sites were included in the “River/Coast". Most sites were visited three times a year, but some sites might have been visited only once (or not at all) in a any given year.

Any site with only one year of data or where no birds were ever detected were not included in our analysis or figures.

A separate hierarchical binomial mixture (N-mixture) model was fit to each of the two geographic regions (Puget Lowlands and Columbia River/Coast) with four visit-level detection parameter terms for adult males, females, and linear effects of wind speed for each sex (using a logit link). Detection terms are common across sites, years and first detection (audio or visual). The implication of fitting the model to the River/Coast and Puget Lowland regions separately is that sites within a region do not share information between the two regions. We feel this separation is likely given the geographic distance between these regions and based on our information on within and between breeding season dispersal among sites and regions (Pearson et al. 2008, Wolf et al. 2019). Furthermore, inspection of the raw data suggests differences in abundance trends and detectability between the two regions, which also indicates that modelling the two regions independently is warranted (see Results).

Unclassified (sex and/or age) birds contributed to site and year specific estimates (*n*) with probabilities calculated from the conditional distributions from known male and female detections that were either visually detected or detected calling. Any singing bird was classified as a male with probability 1 because only males have been observed singing. Uniform priors were placed on all common terms across sites and years in a region.

The population observed at each site *x* year combination was assumed to have a Poisson distribution with regional mean growth rates for males and females and an autoregressive first order multiple of annual growth rate. We assess growth rate of density not abundance because it was necessary to offset density by transect length because of differences in transect length between years for a given site.

Analytical approach - In other words, for visit $l \in \{1, 2, \ldots. L_{ij}\}$ to site $i \in \{1,2, \ldots I\}$ in year $j \in \{1, 2, \ldots, 9\}$ and sex $k \in$ {males, females}, observed counts Y:

$Y_{IJKL} \sim Binom(\theta_k, n_{ijk} - u_{ijkl})$	where u_{ijkl} are unclassified birds	(1)
$logit(\theta_k) = \bar{p}_k + \beta_k^p W$	where W is wind speed	(2)
$n_{ijk} \sim Poisson(e^{u_{jk}} t_{ij})$	where t is a transect length offset term	(3)
$u_{jk} = u_{j-1k} + ln\,(\lambda_k)$	for $j \geq 2$ and a diffused prior on u_{jk}	(4)

To estimate the number of unclassified birds u_{ijkl} we first considered the likelihood of a classified bird (both adult and unknown age) being visually detected (as opposed to an aural detection), where *V* is the number detected visually with proportion *Φ* out of *D* detected either visually or aurally (calling only).

$$V_K \sim Binom(\Phi_k, D_k) \tag{5}$$

The standardized probabilities of an unknown-sex bird being a male given method of detection are then:

$$\Pr(male|visual) = \frac{1}{1 + \frac{\Phi f}{\Phi m}} \tag{6}$$

$$\Pr(male|aural) = \frac{1}{1 + \frac{1 - \Phi f}{1 - \Phi m}} \tag{7}$$

The probability of an unknown-sex bird being a female is the compliment:

$$\Pr(female|visual) = 1 - \Pr(male|visual) \tag{8}$$

$$\Pr(female|visual) = 1 - \Pr(male|aural) \tag{9}$$

The above gives you the same result as when Bayes rule is applied as follows:

$$\Pr(sex|detection) \propto \Pr(detection|sex)\pi(sex) \tag{10}$$

The unclassified larks were multiplied by the probabilities in equations 6-9. We then multiplied the unclassified age by a uniform probability of being an adult, which produces the required quantity u_{ijkl}.

Our model was fit in JAGS 4.3.1 (Plummer, 2003; Appendix 1) called from R 4.2.2 (R Development Core Team 2023). Three independent chains were initialized with over-dispersed starting values were run for 7,500 iterations with the first 2,500 discarded (burn in period) and one of every ten were retained after the burn-in period for a sample of 1,500 independent draws from the posterior. Convergence of MCMC chains was checked by visual inspection of trace plots and a Gelman and Rubin's $\hat{R}$ diagnostic.

Sites with at least one year of abundance surveys were retained, all occupancy surveys were removed along with all partial surveys or surveys with wind speed ≥ 15 mph. Data in our analyses include sites surveyed between 2010 and 2023. The new 2023 transects and results from the Southeast corner of the Olympia Airport were not included because they added 7,354 m of transect (67% more survey area to that site) and only one unclassified lark was detected. Adding these transect has a strong influence on the long-term trends (past and current) for this site and the entire region. This occurs because information is shared in our modelling approach among sites and years.

RESULTS

For the Puget Sound region, our estimate of lambda was 0.98 (0.96-0.99) for females and 1.02 (1.01-1.03) for males indicating a declining female population and a stable to increasing male population. For the

Columbia River/Washington Coast, our estimate of lambda was 1.00 (0.97-1.02) for females and 0.98 (0.96-0.99) for males indicating a stable female population and a declining male population.

Table 1. Male and female detection probabilities (low/high bounds of a 95% highest posterior density interval). Note the much higher detection probability for males than females in all regions. This is not surprising given that males sing, perch on high ground and objects/rocks, and conduct flight displays. Both males and females appear less detectable in prairies when compared to airports (mowed) and river/coast habitats that are very sparsely vegetated.

Sex	Region	Mean	Lwr95HPD	Upr95HPD
Males	Prairie	0.341	0.292	0.388
	Airports	0.529	0.479	0.58
	River/Coast	0.585	0.546	0.622
Females	Prairie	0.102	0.066	0.14
	Airports	0.278	0.202	0.358
	River/Coast	0.383	0.324	0.437

Table 2. Influence of wind on probability of detection by sex and region. Note that there is no effect of wind on detection when the low/high bounds of the highest posterior density intervals overlap 1.0. Because the high/low bounds do not overlap zero for Airport males, this indicates a decrease in detection probability for every 1 mph increase in wind speed. Because of the wind protocol (<15mph), it is not surprising that wind does not have a strong influence on detection for most regions.

Sex	Region	Mean	Lwr95HPD	Upr95HPD
Males	Prairie	1.004	0.952	1.052
	Airports	0.943	0.887	0.999
	River/Coast	0.992	0.97	1.015
Females	Prairie	1.017	0.967	1.076
	Airports	0.954	0.901	1.015
	River/Coast	1.014	0.988	1.045

Table 3. Mean percent of males detected audibly, and females detected visually by region (low/high bounds of a 95% highest posterior density interval). Most of the males are detected audibly and about half of the females are detected visually.

Sex	Region	Mean	Lwr95HPD	Upr95HPD
Males	Puget	65	60	71
	River/Coast	72	67	77
Females	Puget	52	51	53
	River/Coast	53	53	54

DISCUSSION

The Puget Sound region female lark population is continuing to decline while the male lark population is slightly increasing. On the Washington coast/Columbia River, the female population appears stable while the male population is slightly declining. A declining female population in the Puget Sound region is particularly worrisome given the importance of females to population recruitment and ultimately population growth. The declining male population on the Coast/Columbia River sites is less concerning given the stable female population unless some females are not able to find mates due to a decreasing male population.

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Figure 1: Site-specific trends in abundance of males and females for Puget region

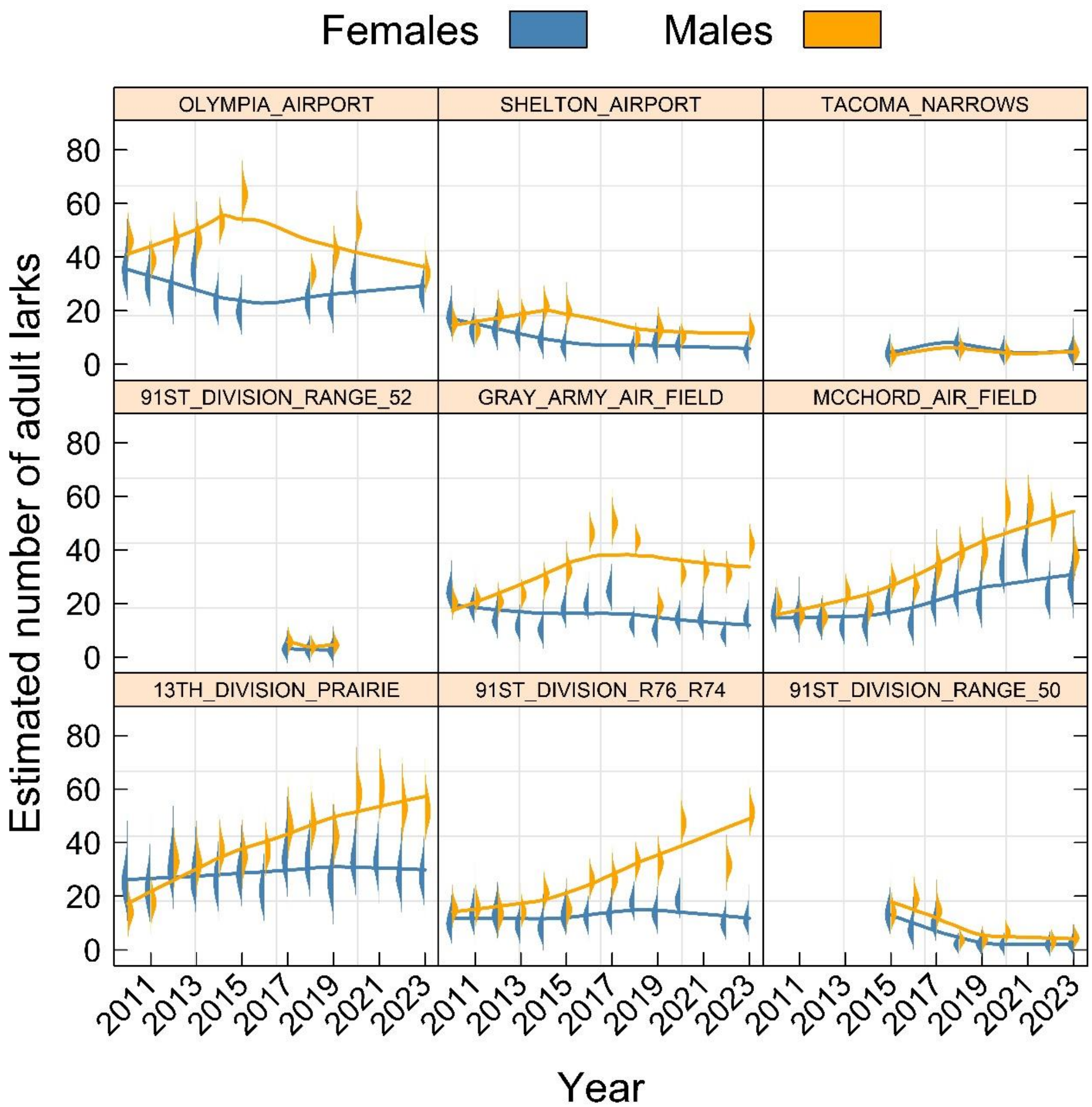
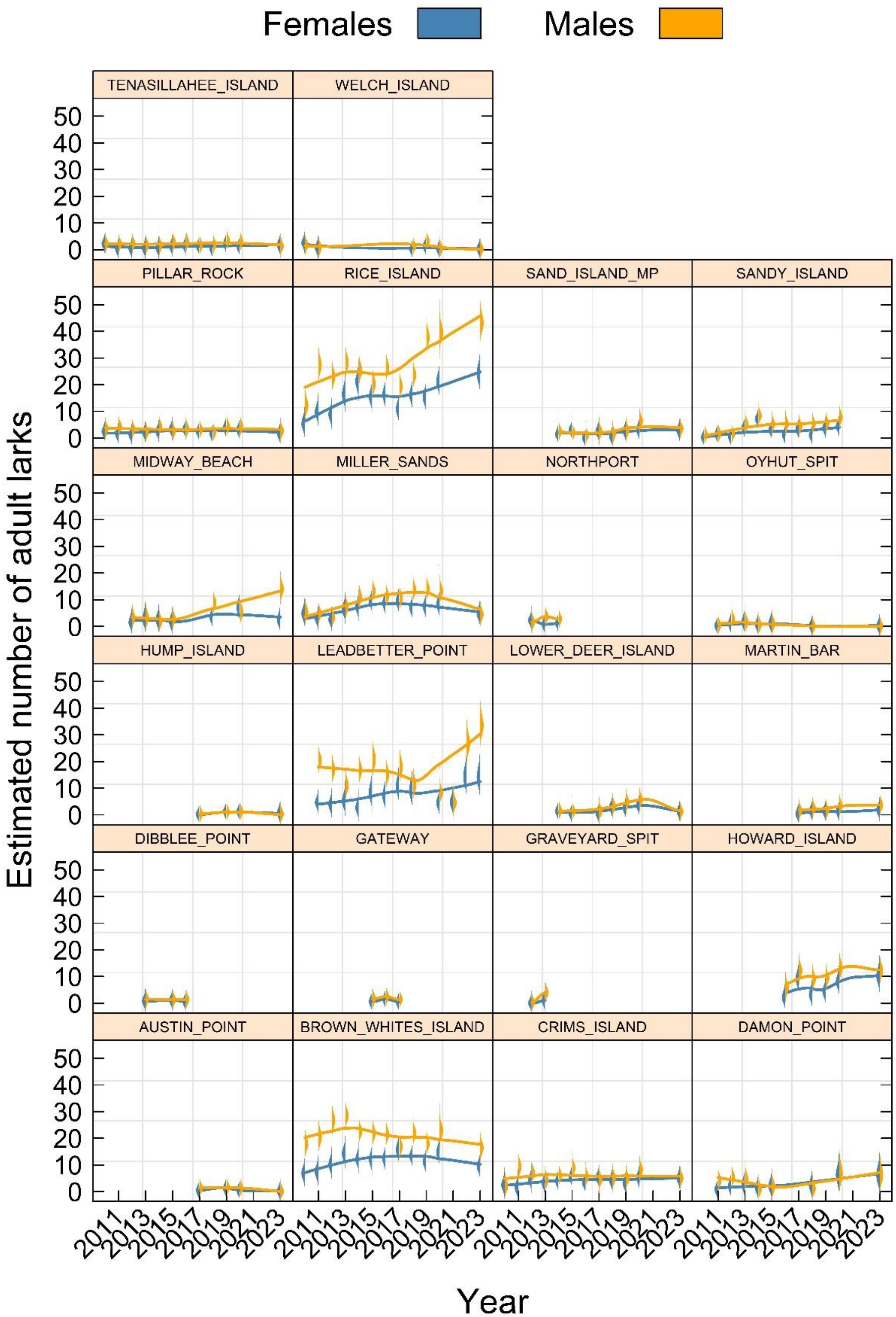


Figure 2. Site-specific trends in abundance of males and females for River/Coast region



Appendix 1. Estimated number of Male and Female larks (95% credible interval) by site and year.

Sex	Year	Site	Lwr CRI	Estimate	Upr CRI
Females	2010	13TH_DIVISION_PRAIRIE	15	26	44
Males	2010	13TH_DIVISION_PRAIRIE	8	14	22
Females	2011	13TH_DIVISION_PRAIRIE	13	23	40
Males	2011	13TH_DIVISION_PRAIRIE	12	18	26
Females	2012	13TH_DIVISION_PRAIRIE	20	31	47
Males	2012	13TH_DIVISION_PRAIRIE	26	33	43
Females	2013	13TH_DIVISION_PRAIRIE	17	28	45
Males	2013	13TH_DIVISION_PRAIRIE	25	33	42
Females	2014	13TH_DIVISION_PRAIRIE	15	26	41
Males	2014	13TH_DIVISION_PRAIRIE	29	37	47
Females	2015	13TH_DIVISION_PRAIRIE	19	29	45
Males	2015	13TH_DIVISION_PRAIRIE	27	35	45
Females	2016	13TH_DIVISION_PRAIRIE	12	23	37
Males	2016	13TH_DIVISION_PRAIRIE	30	37	47
Females	2017	13TH_DIVISION_PRAIRIE	24	35	51
Males	2017	13TH_DIVISION_PRAIRIE	37	46	57
Females	2018	13TH_DIVISION_PRAIRIE	22	33	49
Males	2018	13TH_DIVISION_PRAIRIE	39	47	59
Females	2019	13TH_DIVISION_PRAIRIE	16	26	42
Males	2019	13TH_DIVISION_PRAIRIE	34	43	54
Females	2020	13TH_DIVISION_PRAIRIE	23	34	48
Males	2020	13TH_DIVISION_PRAIRIE	49	59	70
Females	2021	13TH_DIVISION_PRAIRIE	23	34	49
Males	2021	13TH_DIVISION_PRAIRIE	51	61	73
Females	2022	13TH_DIVISION_PRAIRIE	18	28	42
Males	2022	13TH_DIVISION_PRAIRIE	44	54	65
Females	2023	13TH_DIVISION_PRAIRIE	19	28	41
Males	2023	13TH_DIVISION_PRAIRIE	43	53	65
Females	2010	91ST_DIVISION_R76_R74	4	10	19
Males	2010	91ST_DIVISION_R76_R74	11	15	21
Females	2011	91ST_DIVISION_R76_R74	7	14	24
Males	2011	91ST_DIVISION_R76_R74	10	16	23
Females	2012	91ST_DIVISION_R76_R74	7	14	23
Males	2012	91ST_DIVISION_R76_R74	8	14	21
Females	2013	91ST_DIVISION_R76_R74	4	9	18
Males	2013	91ST_DIVISION_R76_R74	10	14	20
Females	2014	91ST_DIVISION_R76_R74	3	9	16
Males	2014	91ST_DIVISION_R76_R74	17	21	27
Females	2015	91ST_DIVISION_R76_R74	8	13	23
Males	2015	91ST_DIVISION_R76_R74	11	15	21
Females	2016	91ST_DIVISION_R76_R74	7	13	20
Males	2016	91ST_DIVISION_R76_R74	21	26	33
Females	2017	91ST_DIVISION_R76_R74	8	13	21
Males	2017	91ST_DIVISION_R76_R74	22	27	33

Sex	Year	Site	Lwr CRI	Estimate	Upr CRI
Females	2018	91ST_DIVISION_R76_R74	12	18	26
Males	2018	91ST_DIVISION_R76_R74	27	33	39
Females	2019	91ST_DIVISION_R76_R74	9	14	21
Males	2019	91ST_DIVISION_R76_R74	27	33	40
Females	2020	91ST_DIVISION_R76_R74	14	19	26
Males	2020	91ST_DIVISION_R76_R74	41	48	55
Females	2022	91ST_DIVISION_R76_R74	6	10	17
Males	2022	91ST_DIVISION_R76_R74	26	32	39
Females	2023	91ST_DIVISION_R76_R74	7	12	18
Males	2023	91ST_DIVISION_R76_R74	44	51	59
Females	2015	91ST_DIVISION_RANGE_50	8	14	23
Males	2015	91ST_DIVISION_RANGE_50	9	14	21
Females	2016	91ST_DIVISION_RANGE_50	3	8	15
Males	2016	91ST_DIVISION_RANGE_50	15	19	26
Females	2017	91ST_DIVISION_RANGE_50	5	10	17
Males	2017	91ST_DIVISION_RANGE_50	10	15	21
Females	2018	91ST_DIVISION_RANGE_50	1	2	6
Males	2018	91ST_DIVISION_RANGE_50	2	4	6
Females	2019	91ST_DIVISION_RANGE_50	0	2	6
Males	2019	91ST_DIVISION_RANGE_50	2	4	6
Females	2020	91ST_DIVISION_RANGE_50	0	2	6
Males	2020	91ST_DIVISION_RANGE_50	4	7	10
Females	2022	91ST_DIVISION_RANGE_50	0	2	6
Males	2022	91ST_DIVISION_RANGE_50	1	3	7
Females	2023	91ST_DIVISION_RANGE_50	1	2	5
Males	2023	91ST_DIVISION_RANGE_50	2	5	8
Females	2017	91ST_DIVISION_RANGE_52	0	3	7
Males	2017	91ST_DIVISION_RANGE_52	4	6	9
Females	2018	91ST_DIVISION_RANGE_52	0	3	7
Males	2018	91ST_DIVISION_RANGE_52	2	4	7
Females	2019	91ST_DIVISION_RANGE_52	0	3	7
Males	2019	91ST_DIVISION_RANGE_52	3	5	8
Females	2010	GRAY_ARMY_AIR_FIELD	19	25	35
Males	2010	GRAY_ARMY_AIR_FIELD	17	20	25
Females	2011	GRAY_ARMY_AIR_FIELD	14	19	27
Males	2011	GRAY_ARMY_AIR_FIELD	18	22	26
Females	2012	GRAY_ARMY_AIR_FIELD	10	14	22
Males	2012	GRAY_ARMY_AIR_FIELD	17	21	26
Females	2013	GRAY_ARMY_AIR_FIELD	7	12	19
Males	2013	GRAY_ARMY_AIR_FIELD	20	23	28
Females	2014	GRAY_ARMY_AIR_FIELD	6	11	17
Males	2014	GRAY_ARMY_AIR_FIELD	24	28	33
Females	2015	GRAY_ARMY_AIR_FIELD	13	18	26
Males	2015	GRAY_ARMY_AIR_FIELD	28	32	38
Females	2016	GRAY_ARMY_AIR_FIELD	15	20	28
Males	2016	GRAY_ARMY_AIR_FIELD	41	46	53

Sex	Year	Site	Lwr CRI	Estimate	Upr CRI
Females	2017	GRAY_ARMY_AIR_FIELD	20	25	33
Males	2017	GRAY_ARMY_AIR_FIELD	45	50	57
Females	2018	GRAY_ARMY_AIR_FIELD	9	13	19
Males	2018	GRAY_ARMY_AIR_FIELD	40	44	48
Females	2019	GRAY_ARMY_AIR_FIELD	6	10	17
Males	2019	GRAY_ARMY_AIR_FIELD	15	19	24
Females	2020	GRAY_ARMY_AIR_FIELD	11	14	20
Males	2020	GRAY_ARMY_AIR_FIELD	27	31	37
Females	2021	GRAY_ARMY_AIR_FIELD	10	14	21
Males	2021	GRAY_ARMY_AIR_FIELD	28	33	38
Females	2022	GRAY_ARMY_AIR_FIELD	6	9	14
Males	2022	GRAY_ARMY_AIR_FIELD	27	31	36
Females	2023	GRAY_ARMY_AIR_FIELD	11	15	22
Males	2023	GRAY_ARMY_AIR_FIELD	37	42	48
Females	2010	MCCHORD_AIR_FIELD	11	17	25
Males	2010	MCCHORD_AIR_FIELD	16	20	26
Females	2011	MCCHORD_AIR_FIELD	10	15	23
Males	2011	MCCHORD_AIR_FIELD	13	16	20
Females	2012	MCCHORD_AIR_FIELD	9	13	21
Males	2012	MCCHORD_AIR_FIELD	12	15	20
Females	2013	MCCHORD_AIR_FIELD	6	12	21
Males	2013	MCCHORD_AIR_FIELD	20	24	30
Females	2014	MCCHORD_AIR_FIELD	7	13	22
Males	2014	MCCHORD_AIR_FIELD	15	19	24
Females	2015	MCCHORD_AIR_FIELD	14	20	31
Males	2015	MCCHORD_AIR_FIELD	23	28	35
Females	2016	MCCHORD_AIR_FIELD	7	13	22
Males	2016	MCCHORD_AIR_FIELD	22	26	33
Females	2017	MCCHORD_AIR_FIELD	14	22	36
Males	2017	MCCHORD_AIR_FIELD	28	34	42
Females	2018	MCCHORD_AIR_FIELD	16	25	39
Males	2018	MCCHORD_AIR_FIELD	34	39	47
Females	2019	MCCHORD_AIR_FIELD	13	22	36
Males	2019	MCCHORD_AIR_FIELD	33	40	48
Females	2020	MCCHORD_AIR_FIELD	26	35	48
Males	2020	MCCHORD_AIR_FIELD	48	56	66
Females	2021	MCCHORD_AIR_FIELD	31	40	53
Males	2021	MCCHORD_AIR_FIELD	48	56	65
Females	2022	MCCHORD_AIR_FIELD	16	24	36
Males	2022	MCCHORD_AIR_FIELD	45	52	61
Females	2023	MCCHORD_AIR_FIELD	20	28	42
Males	2023	MCCHORD_AIR_FIELD	31	38	47
Females	2010	OLYMPIA_AIRPORT	27	36	51
Males	2010	OLYMPIA_AIRPORT	41	46	54
Females	2011	OLYMPIA_AIRPORT	23	32	45
Males	2011	OLYMPIA_AIRPORT	34	39	46

Sex	Year	Site	Lwr CRI	Estimate	Upr CRI
Females	2012	OLYMPIA_AIRPORT	19	27	39
Males	2012	OLYMPIA_AIRPORT	40	47	55
Females	2013	OLYMPIA_AIRPORT	28	36	50
Males	2013	OLYMPIA_AIRPORT	41	47	54
Females	2014	OLYMPIA_AIRPORT	16	24	35
Males	2014	OLYMPIA_AIRPORT	47	53	61
Females	2015	OLYMPIA_AIRPORT	13	20	31
Males	2015	OLYMPIA_AIRPORT	57	64	73
Females	2018	OLYMPIA_AIRPORT	17	24	35
Males	2018	OLYMPIA_AIRPORT	29	34	41
Females	2019	OLYMPIA_AIRPORT	16	23	33
Males	2019	OLYMPIA_AIRPORT	36	42	50
Females	2020	OLYMPIA_AIRPORT	25	33	44
Males	2020	OLYMPIA_AIRPORT	45	52	60
Females	2023	OLYMPIA_AIRPORT	21	27	37
Males	2023	OLYMPIA_AIRPORT	28	34	42
Females	2010	SHELTON_AIRPORT	13	18	28
Males	2010	SHELTON_AIRPORT	12	16	20
Females	2011	SHELTON_AIRPORT	8	13	21
Males	2011	SHELTON_AIRPORT	9	13	17
Females	2012	SHELTON_AIRPORT	8	13	22
Males	2012	SHELTON_AIRPORT	15	19	25
Females	2013	SHELTON_AIRPORT	7	12	20
Males	2013	SHELTON_AIRPORT	15	18	23
Females	2014	SHELTON_AIRPORT	5	10	17
Males	2014	SHELTON_AIRPORT	18	22	28
Females	2015	SHELTON_AIRPORT	3	7	14
Males	2015	SHELTON_AIRPORT	16	20	25
Females	2018	SHELTON_AIRPORT	2	6	12
Males	2018	SHELTON_AIRPORT	7	10	14
Females	2019	SHELTON_AIRPORT	3	8	15
Males	2019	SHELTON_AIRPORT	9	13	19
Females	2020	SHELTON_AIRPORT	3	7	14
Males	2020	SHELTON_AIRPORT	8	10	15
Females	2023	SHELTON_AIRPORT	2	5	11
Males	2023	SHELTON_AIRPORT	9	13	18
Females	2015	TACOMA_NARROWS	1	4	11
Males	2015	TACOMA_NARROWS	1	3	7
Females	2018	TACOMA_NARROWS	4	8	14
Males	2018	TACOMA_NARROWS	3	6	10
Females	2020	TACOMA_NARROWS	1	5	10
Males	2020	TACOMA_NARROWS	2	4	8
Females	2023	TACOMA_NARROWS	1	5	11
Males	2023	TACOMA_NARROWS	2	5	9
Females	2017	AUSTIN_POINT	0	0	2
Males	2017	AUSTIN_POINT	1	1	2

Sex	Year	Site	Lwr CRI	Estimate	Upr CRI
Females	2019	AUSTIN_POINT	1	1	3
Males	2019	AUSTIN_POINT	1	2	3
Females	2020	AUSTIN_POINT	0	1	2
Males	2020	AUSTIN_POINT	1	1	2
Females	2023	AUSTIN_POINT	0	0	2
Males	2023	AUSTIN_POINT	0	0	1
Females	2010	BROWN_WHITES_ISLAND	4	7	10
Males	2010	BROWN_WHITES_ISLAND	15	18	22
Females	2011	BROWN_WHITES_ISLAND	5	8	11
Males	2011	BROWN_WHITES_ISLAND	17	21	25
Females	2012	BROWN_WHITES_ISLAND	7	10	14
Males	2012	BROWN_WHITES_ISLAND	23	27	31
Females	2013	BROWN_WHITES_ISLAND	12	14	18
Males	2013	BROWN_WHITES_ISLAND	26	29	32
Females	2014	BROWN_WHITES_ISLAND	10	12	16
Males	2014	BROWN_WHITES_ISLAND	21	23	26
Females	2015	BROWN_WHITES_ISLAND	9	12	16
Males	2015	BROWN_WHITES_ISLAND	19	22	26
Females	2016	BROWN_WHITES_ISLAND	10	12	16
Males	2016	BROWN_WHITES_ISLAND	19	22	25
Females	2017	BROWN_WHITES_ISLAND	13	16	20
Males	2017	BROWN_WHITES_ISLAND	14	17	20
Females	2018	BROWN_WHITES_ISLAND	12	13	17
Males	2018	BROWN_WHITES_ISLAND	19	22	26
Females	2019	BROWN_WHITES_ISLAND	9	11	15
Males	2019	BROWN_WHITES_ISLAND	16	18	21
Females	2020	BROWN_WHITES_ISLAND	12	15	19
Males	2020	BROWN_WHITES_ISLAND	20	23	26
Females	2023	BROWN_WHITES_ISLAND	8	10	12
Males	2023	BROWN_WHITES_ISLAND	14	17	20
Females	2010	CRIMS_ISLAND	1	3	6
Males	2010	CRIMS_ISLAND	0	2	6
Females	2011	CRIMS_ISLAND	0	2	5
Males	2011	CRIMS_ISLAND	7	9	13
Females	2012	CRIMS_ISLAND	3	5	7
Males	2012	CRIMS_ISLAND	5	7	9
Females	2013	CRIMS_ISLAND	2	3	6
Males	2013	CRIMS_ISLAND	3	4	6
Females	2014	CRIMS_ISLAND	3	4	6
Males	2014	CRIMS_ISLAND	5	6	8
Females	2015	CRIMS_ISLAND	5	6	8
Males	2015	CRIMS_ISLAND	7	9	11
Females	2016	CRIMS_ISLAND	3	3	5
Males	2016	CRIMS_ISLAND	5	5	7
Females	2017	CRIMS_ISLAND	5	5	7
Males	2017	CRIMS_ISLAND	4	4	6

Sex	Year	Site	Lwr CRI	Estimate	Upr CRI
Females	2018	CRIMS_ISLAND	3	4	7
Males	2018	CRIMS_ISLAND	4	5	7
Females	2019	CRIMS_ISLAND	2	3	6
Males	2019	CRIMS_ISLAND	3	5	7
Females	2020	CRIMS_ISLAND	4	5	8
Males	2020	CRIMS_ISLAND	6	8	11
Females	2023	CRIMS_ISLAND	4	5	8
Males	2023	CRIMS_ISLAND	4	5	7
Females	2011	DAMON_POINT	0	1	3
Males	2011	DAMON_POINT	3	4	6
Females	2012	DAMON_POINT	0	2	6
Males	2012	DAMON_POINT	3	5	8
Females	2013	DAMON_POINT	1	3	7
Males	2013	DAMON_POINT	3	5	8
Females	2014	DAMON_POINT	0	1	4
Males	2014	DAMON_POINT	0	1	3
Females	2015	DAMON_POINT	0	2	6
Males	2015	DAMON_POINT	0	2	5
Females	2018	DAMON_POINT	0	3	7
Males	2018	DAMON_POINT	0	1	4
Females	2020	DAMON_POINT	2	7	12
Males	2020	DAMON_POINT	3	7	13
Females	2023	DAMON_POINT	2	6	12
Males	2023	DAMON_POINT	2	6	13
Females	2013	DIBBLEE_POINT	0	1	3
Males	2013	DIBBLEE_POINT	1	1	3
Females	2015	DIBBLEE_POINT	1	1	3
Males	2015	DIBBLEE_POINT	1	1	2
Females	2016	DIBBLEE_POINT	0	1	2
Males	2016	DIBBLEE_POINT	1	1	3
Females	2015	GATEWAY	0	1	2
Males	2015	GATEWAY	1	1	3
Females	2016	GATEWAY	1	2	3
Males	2016	GATEWAY	2	2	4
Females	2017	GATEWAY	0	0	2
Males	2017	GATEWAY	1	1	2
Females	2012	GRAVEYARD_SPIT	0	0	1
Males	2012	GRAVEYARD_SPIT	0	0	1
Females	2013	GRAVEYARD_SPIT	0	1	4
Males	2013	GRAVEYARD_SPIT	3	4	6
Females	2016	HOWARD_ISLAND	0	2	6
Males	2016	HOWARD_ISLAND	4	6	9
Females	2017	HOWARD_ISLAND	7	9	13
Males	2017	HOWARD_ISLAND	10	12	16
Females	2018	HOWARD_ISLAND	1	3	8
Males	2018	HOWARD_ISLAND	7	9	12

Sex	Year	Site	Lwr CRI	Estimate	Upr CRI
Females	2019	HOWARD_ISLAND	3	5	8
Males	2019	HOWARD_ISLAND	8	9	12
Females	2020	HOWARD_ISLAND	6	8	12
Males	2020	HOWARD_ISLAND	10	13	17
Females	2023	HOWARD_ISLAND	7	10	15
Males	2023	HOWARD_ISLAND	10	12	16
Females	2017	HUMP_ISLAND	0	0	2
Males	2017	HUMP_ISLAND	0	0	1
Females	2019	HUMP_ISLAND	1	1	3
Males	2019	HUMP_ISLAND	1	1	2
Females	2020	HUMP_ISLAND	1	1	3
Males	2020	HUMP_ISLAND	1	1	3
Females	2023	HUMP_ISLAND	0	1	3
Males	2023	HUMP_ISLAND	0	0	2
Females	2011	LEADBETTER_POINT	4	5	7
Males	2011	LEADBETTER_POINT	18	21	24
Females	2012	LEADBETTER_POINT	2	4	7
Males	2012	LEADBETTER_POINT	14	17	21
Females	2013	LEADBETTER_POINT	3	5	10
Males	2013	LEADBETTER_POINT	8	11	16
Females	2014	LEADBETTER_POINT	1	3	7
Males	2014	LEADBETTER_POINT	14	17	21
Females	2015	LEADBETTER_POINT	4	9	15
Males	2015	LEADBETTER_POINT	16	21	27
Females	2016	LEADBETTER_POINT	4	7	13
Males	2016	LEADBETTER_POINT	12	15	20
Females	2017	LEADBETTER_POINT	6	11	18
Males	2017	LEADBETTER_POINT	14	18	24
Females	2018	LEADBETTER_POINT	4	10	16
Males	2018	LEADBETTER_POINT	7	11	17
Females	2020	LEADBETTER_POINT	2	5	8
Males	2020	LEADBETTER_POINT	7	8	11
Females	2021	LEADBETTER_POINT	3	5	9
Males	2021	LEADBETTER_POINT	3	5	8
Females	2022	LEADBETTER_POINT	10	15	21
Males	2022	LEADBETTER_POINT	22	27	33
Females	2023	LEADBETTER_POINT	9	15	22
Males	2023	LEADBETTER_POINT	29	34	40
Females	2014	LOWER_DEER_ISLAND	1	1	3
Males	2014	LOWER_DEER_ISLAND	1	2	4
Females	2015	LOWER_DEER_ISLAND	0	0	2
Males	2015	LOWER_DEER_ISLAND	1	1	2
Females	2017	LOWER_DEER_ISLAND	0	1	2
Males	2017	LOWER_DEER_ISLAND	1	1	3
Females	2018	LOWER_DEER_ISLAND	2	3	5
Males	2018	LOWER_DEER_ISLAND	3	3	5

Sex	Year	Site	Lwr CRI	Estimate	Upr CRI
Females	2019	LOWER_DEER_ISLAND	2	2	4
Males	2019	LOWER_DEER_ISLAND	4	5	7
Females	2020	LOWER_DEER_ISLAND	3	3	5
Males	2020	LOWER_DEER_ISLAND	5	6	7
Females	2023	LOWER_DEER_ISLAND	1	1	3
Males	2023	LOWER_DEER_ISLAND	1	1	3
Females	2017	MARTIN_BAR	0	0	2
Males	2017	MARTIN_BAR	1	1	3
Females	2018	MARTIN_BAR	1	1	3
Males	2018	MARTIN_BAR	2	2	4
Females	2019	MARTIN_BAR	1	1	3
Males	2019	MARTIN_BAR	1	2	3
Females	2020	MARTIN_BAR	1	1	3
Males	2020	MARTIN_BAR	3	3	5
Females	2023	MARTIN_BAR	1	2	4
Males	2023	MARTIN_BAR	3	4	5
Females	2012	MIDWAY_BEACH	0	2	5
Males	2012	MIDWAY_BEACH	2	3	6
Females	2013	MIDWAY_BEACH	1	3	7
Males	2013	MIDWAY_BEACH	1	3	7
Females	2014	MIDWAY_BEACH	1	3	6
Males	2014	MIDWAY_BEACH	1	2	4
Females	2015	MIDWAY_BEACH	0	2	5
Males	2015	MIDWAY_BEACH	2	3	5
Females	2018	MIDWAY_BEACH	2	4	7
Males	2018	MIDWAY_BEACH	7	9	12
Females	2020	MIDWAY_BEACH	4	7	11
Males	2020	MIDWAY_BEACH	3	5	9
Females	2023	MIDWAY_BEACH	1	3	6
Males	2023	MIDWAY_BEACH	11	14	18
Females	2010	MILLER_SANDS	2	5	9
Males	2010	MILLER_SANDS	3	5	9
Females	2011	MILLER_SANDS	2	3	5
Males	2011	MILLER_SANDS	4	5	7
Females	2012	MILLER_SANDS	2	2	5
Males	2012	MILLER_SANDS	3	3	5
Females	2013	MILLER_SANDS	4	7	10
Males	2013	MILLER_SANDS	5	7	10
Females	2014	MILLER_SANDS	5	7	11
Males	2014	MILLER_SANDS	9	11	14
Females	2015	MILLER_SANDS	8	10	13
Males	2015	MILLER_SANDS	12	13	16
Females	2016	MILLER_SANDS	6	9	12
Males	2016	MILLER_SANDS	9	11	14
Females	2017	MILLER_SANDS	7	10	14
Males	2017	MILLER_SANDS	8	11	14

Sex	Year	Site	Lwr CRI	Estimate	Upr CRI
Females	2018	MILLER_SANDS	5	7	10
Males	2018	MILLER_SANDS	12	14	17
Females	2019	MILLER_SANDS	5	8	11
Males	2019	MILLER_SANDS	12	14	17
Females	2020	MILLER_SANDS	6	8	12
Males	2020	MILLER_SANDS	11	13	17
Females	2023	MILLER_SANDS	3	5	8
Males	2023	MILLER_SANDS	3	4	7
Females	2012	NORTHPORT	2	2	4
Males	2012	NORTHPORT	1	2	3
Females	2013	NORTHPORT	0	1	2
Males	2013	NORTHPORT	3	4	5
Females	2014	NORTHPORT	1	1	3
Males	2014	NORTHPORT	2	3	4
Females	2011	OYHUT_SPIT	0	0	2
Males	2011	OYHUT_SPIT	0	0	2
Females	2012	OYHUT_SPIT	0	1	4
Males	2012	OYHUT_SPIT	2	3	5
Females	2013	OYHUT_SPIT	0	2	5
Males	2013	OYHUT_SPIT	0	2	5
Females	2014	OYHUT_SPIT	0	1	3
Males	2014	OYHUT_SPIT	0	1	2
Females	2015	OYHUT_SPIT	0	1	4
Males	2015	OYHUT_SPIT	0	1	3
Females	2018	OYHUT_SPIT	0	0	2
Males	2018	OYHUT_SPIT	0	0	1
Females	2023	OYHUT_SPIT	0	0	2
Males	2023	OYHUT_SPIT	0	0	1
Females	2010	PILLAR_ROCK	2	2	4
Males	2010	PILLAR_ROCK	3	3	5
Females	2011	PILLAR_ROCK	1	1	3
Males	2011	PILLAR_ROCK	4	4	6
Females	2012	PILLAR_ROCK	1	1	3
Males	2012	PILLAR_ROCK	3	3	5
Females	2013	PILLAR_ROCK	2	2	4
Males	2013	PILLAR_ROCK	2	2	4
Females	2014	PILLAR_ROCK	2	2	4
Males	2014	PILLAR_ROCK	4	4	6
Females	2015	PILLAR_ROCK	3	3	5
Males	2015	PILLAR_ROCK	2	2	4
Females	2016	PILLAR_ROCK	3	3	5
Males	2016	PILLAR_ROCK	3	3	5
Females	2017	PILLAR_ROCK	2	2	4
Males	2017	PILLAR_ROCK	3	3	4
Females	2018	PILLAR_ROCK	1	2	4
Males	2018	PILLAR_ROCK	2	2	3

Sex	Year	Site	Lwr CRI	Estimate	Upr CRI
Females	2019	PILLAR_ROCK	3	4	6
Males	2019	PILLAR_ROCK	3	4	6
Females	2020	PILLAR_ROCK	2	3	5
Males	2020	PILLAR_ROCK	3	4	6
Females	2023	PILLAR_ROCK	1	2	4
Males	2023	PILLAR_ROCK	2	3	5
Females	2010	RICE_ISLAND	3	6	10
Males	2010	RICE_ISLAND	9	12	17
Females	2011	RICE_ISLAND	7	10	15
Males	2011	RICE_ISLAND	24	27	33
Females	2012	RICE_ISLAND	6	9	13
Males	2012	RICE_ISLAND	20	23	27
Females	2013	RICE_ISLAND	13	17	22
Males	2013	RICE_ISLAND	25	28	33
Females	2014	RICE_ISLAND	17	21	27
Males	2014	RICE_ISLAND	22	25	30
Females	2015	RICE_ISLAND	12	16	20
Males	2015	RICE_ISLAND	17	20	25
Females	2016	RICE_ISLAND	13	16	21
Males	2016	RICE_ISLAND	23	26	30
Females	2017	RICE_ISLAND	8	11	15
Males	2017	RICE_ISLAND	16	19	24
Females	2018	RICE_ISLAND	13	16	21
Males	2018	RICE_ISLAND	20	24	28
Females	2019	RICE_ISLAND	12	15	20
Males	2019	RICE_ISLAND	34	38	43
Females	2020	RICE_ISLAND	18	21	26
Males	2020	RICE_ISLAND	36	40	44
Females	2023	RICE_ISLAND	20	25	31
Males	2023	RICE_ISLAND	39	43	49
Females	2014	SAND_ISLAND_MP	1	1	4
Males	2014	SAND_ISLAND_MP	2	2	4
Females	2015	SAND_ISLAND_MP	3	3	4
Males	2015	SAND_ISLAND_MP	2	2	3
Females	2016	SAND_ISLAND_MP	0	0	1
Males	2016	SAND_ISLAND_MP	1	1	2
Females	2017	SAND_ISLAND_MP	2	3	5
Males	2017	SAND_ISLAND_MP	2	2	4
Females	2018	SAND_ISLAND_MP	0	1	2
Males	2018	SAND_ISLAND_MP	1	1	3
Females	2019	SAND_ISLAND_MP	2	3	5
Males	2019	SAND_ISLAND_MP	2	3	5
Females	2020	SAND_ISLAND_MP	2	3	5
Males	2020	SAND_ISLAND_MP	5	6	8
Females	2023	SAND_ISLAND_MP	2	3	5
Males	2023	SAND_ISLAND_MP	3	3	5

Sex	Year	Site	Lwr CRI	Estimate	Upr CRI
Females	2010	SANDY_ISLAND	0	0	2
Males	2010	SANDY_ISLAND	1	1	3
Females	2011	SANDY_ISLAND	1	1	3
Males	2011	SANDY_ISLAND	1	1	4
Females	2012	SANDY_ISLAND	0	0	2
Males	2012	SANDY_ISLAND	1	1	3
Females	2013	SANDY_ISLAND	3	4	6
Males	2013	SANDY_ISLAND	4	5	7
Females	2014	SANDY_ISLAND	7	7	9
Males	2014	SANDY_ISLAND	8	8	10
Females	2015	SANDY_ISLAND	3	3	4
Males	2015	SANDY_ISLAND	5	5	7
Females	2016	SANDY_ISLAND	1	1	2
Males	2016	SANDY_ISLAND	4	5	7
Females	2017	SANDY_ISLAND	3	3	5
Males	2017	SANDY_ISLAND	4	4	6
Females	2018	SANDY_ISLAND	1	1	2
Males	2018	SANDY_ISLAND	5	5	7
Females	2019	SANDY_ISLAND	3	4	6
Males	2019	SANDY_ISLAND	5	5	7
Females	2020	SANDY_ISLAND	4	4	6
Males	2020	SANDY_ISLAND	7	8	10
Females	2010	TENASILLAHEE_ISLAND	2	2	4
Males	2010	TENASILLAHEE_ISLAND	2	2	4
Females	2011	TENASILLAHEE_ISLAND	0	0	2
Males	2011	TENASILLAHEE_ISLAND	2	2	3
Females	2012	TENASILLAHEE_ISLAND	0	0	2
Males	2012	TENASILLAHEE_ISLAND	2	2	4
Females	2013	TENASILLAHEE_ISLAND	0	0	2
Males	2013	TENASILLAHEE_ISLAND	1	2	4
Females	2014	TENASILLAHEE_ISLAND	0	1	2
Males	2014	TENASILLAHEE_ISLAND	1	1	3
Females	2015	TENASILLAHEE_ISLAND	1	1	3
Males	2015	TENASILLAHEE_ISLAND	2	3	4
Females	2016	TENASILLAHEE_ISLAND	1	1	3
Males	2016	TENASILLAHEE_ISLAND	2	3	5
Females	2017	TENASILLAHEE_ISLAND	1	1	3
Males	2017	TENASILLAHEE_ISLAND	1	2	3
Females	2018	TENASILLAHEE_ISLAND	0	0	2
Males	2018	TENASILLAHEE_ISLAND	1	2	4
Females	2019	TENASILLAHEE_ISLAND	2	2	4
Males	2019	TENASILLAHEE_ISLAND	3	3	5
Females	2020	TENASILLAHEE_ISLAND	1	1	3
Males	2020	TENASILLAHEE_ISLAND	2	3	5
Females	2023	TENASILLAHEE_ISLAND	1	2	4
Males	2023	TENASILLAHEE_ISLAND	1	1	3

Sex	Year	Site	Lwr CRI	Estimate	Upr CRI
Females	2010	WELCH_ISLAND	2	2	4
Males	2010	WELCH_ISLAND	1	2	3
Females	2011	WELCH_ISLAND	0	1	3
Males	2011	WELCH_ISLAND	0	1	3
Females	2018	WELCH_ISLAND	0	0	2
Males	2018	WELCH_ISLAND	1	1	3
Females	2019	WELCH_ISLAND	1	1	3
Males	2019	WELCH_ISLAND	3	3	4
Females	2020	WELCH_ISLAND	0	0	2
Males	2020	WELCH_ISLAND	0	0	2
Females	2023	WELCH_ISLAND	0	0	2
Males	2023	WELCH_ISLAND	0	0	1