

**Supplementary Materials for**  
**Population viability at extreme sex-ratio skews produced by**  
**temperature-dependent sex determination**

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Figs. S1-S4

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References

Figure S1. The relationship between the incubation temperature and the primary sex ratio in sea turtle nests. Loggerhead (open circles), olive ridley (diamonds), hawksbill (triangles) and green turtles (crosshairs) data. A logistic model was fitted using the method of least squares ( $r^2 = 0.72$ ,  $p < 0.001$ ):  $f(x) = \frac{1}{1+e^{-1.3(x-29.1)}}$ . A Kruskal-Wallis rank sum test showed no significant difference in the distribution of residuals between all species ( $X^2 = 7.19$ ,  $df = 3$ ,  $p = 0.07$ ) showing the generality of this model fit across species. Data are extracted from: Ackerman RA. 1997. The nest environment and the embryonic development of sea turtles. In: Lutz PL, Musick JA, (editors). Biology of Sea Turtles. Boca Raton. USA, CRC Press, pp. 83-106.

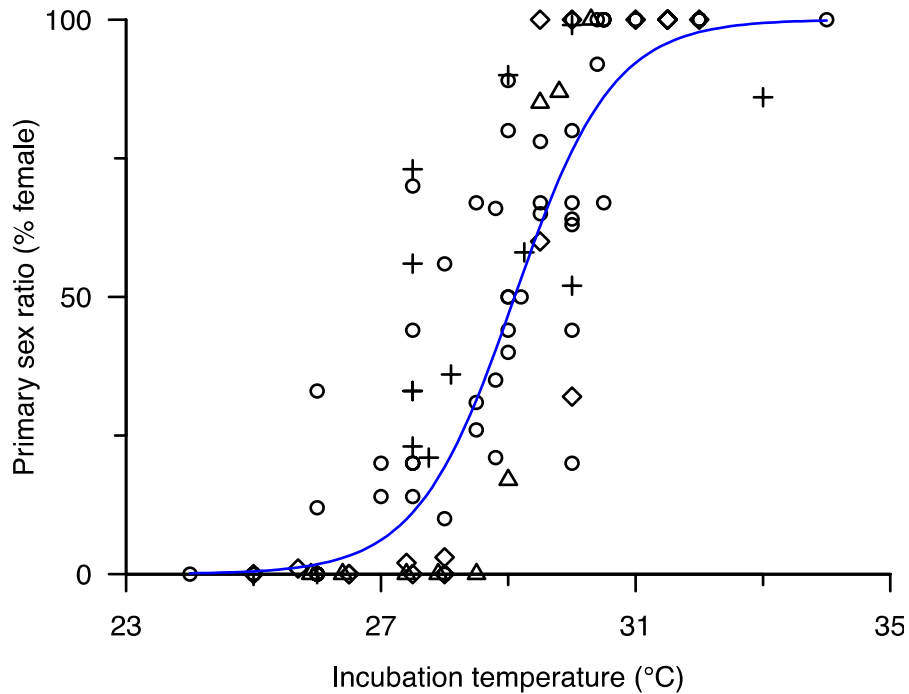


Figure S2. The relationship between the incubation temperature and hatching success in sea turtle nests. Loggerhead (open circles), olive ridley (diamonds), leatherback (triangles), flatback (crosses) and green turtles (crosshairs) data. A logistic model was fitted using the method of least squares ( $r^2 = 0.68$ ,  $p < 0.001$ ):  $f(x) = \frac{0.89}{1+e^{1.2(x-32.6)}}$ . A Kruskal-Wallis rank sum test on the residuals reveals that the function was a good fit for all species ( $X^2 = 4.35$ ,  $df = 4$ ,  $p = 0.36$ ). Data are extracted from: Howard R, Bell II, Pike DA. 2014. Thermal tolerances of sea turtle embryos: current understanding and future directions. *Endangered Species Research* 26: 75-86.

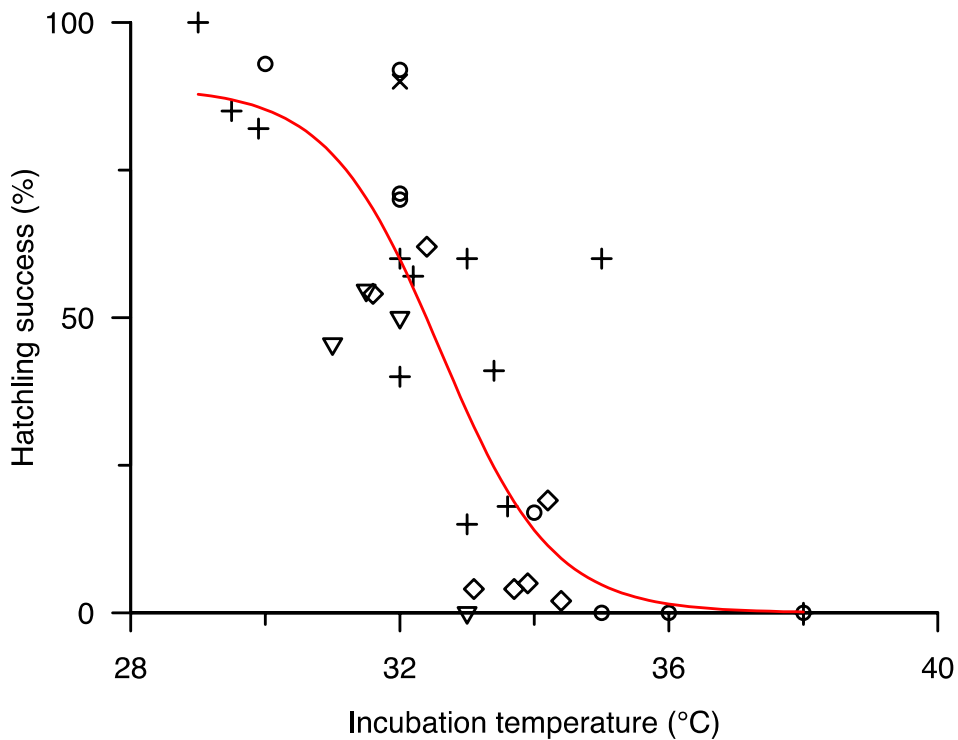


Figure S3. The effects of varying the pivotal temperature for TSD on the relationships between the incubation temperature and the primary sex ratio in nests and hatching success (first column), on the resulting numbers of male and female hatchlings surviving incubation (second column) and on the number of female hatchlings surviving expressed in relation to the primary sex ratio (third column). Points of inflection at 28.0, 29.1, and 30.0°C were modelled (first, second, and third row respectively).

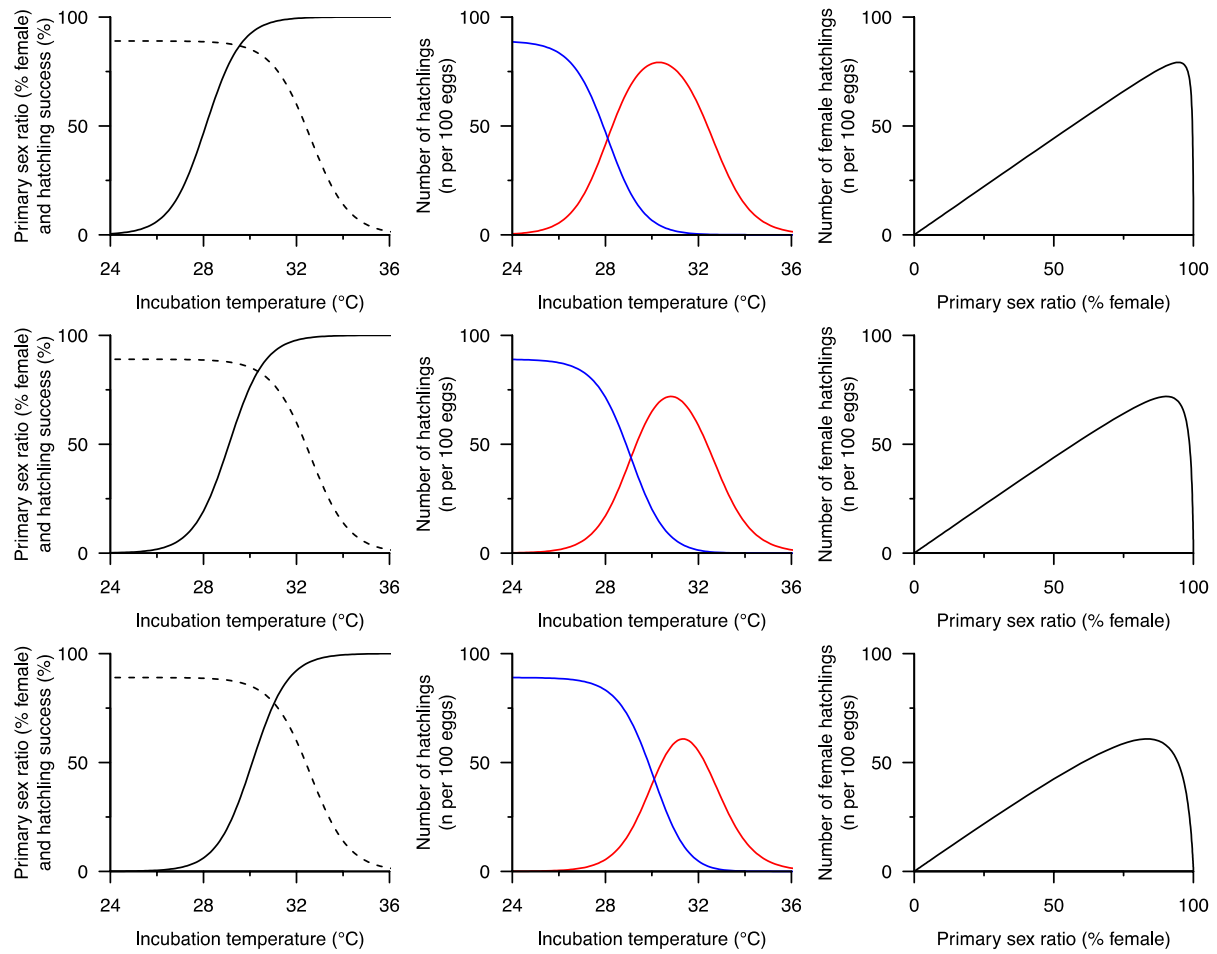


Figure S4. The effects of varying the point of inflection for hatchling survival on the relationships between the incubation temperature and the primary sex ratio in nests and hatching success (first column), on the resulting numbers of male and female hatchlings surviving incubation (second column) and on the number of female hatchling surviving expressed in relation to the primary sex ratio (third column). Points of inflection at 31.5, 32.6, and 33.5°C were modelled (first, second, and third row respectively).

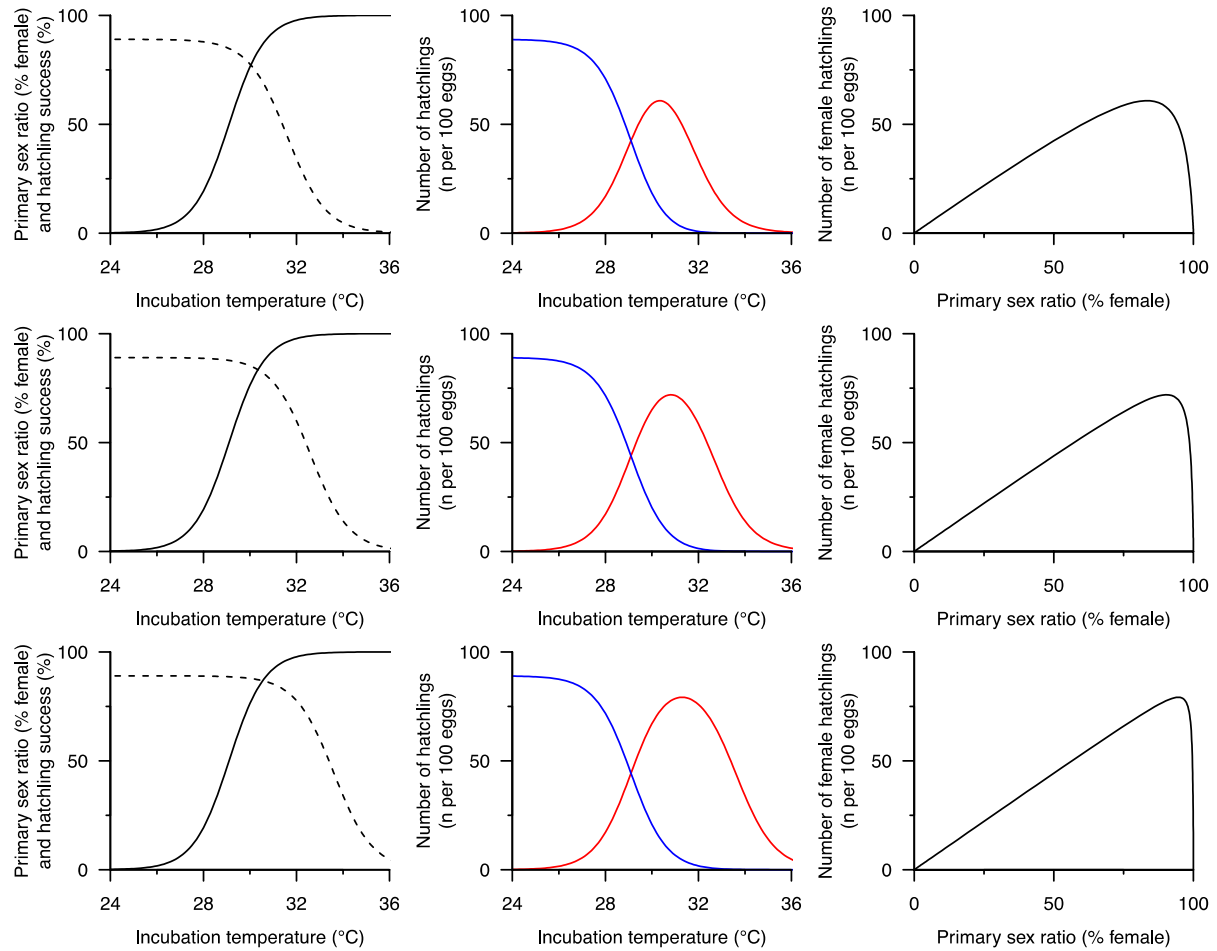


Table S1. **Sex ratio and population size data sources.** CM = *Chelonia mydas*; CC = *Caretta caretta*; DC = *Dermochelys coriacea*; EI = *Eretmochelys imbricata*; LO = *Lepidochelys olivacea*; LK = *Lepidochelys kempii*; ND = *Natator depressus*. Semi colon separates histological examination data from incubation temperature/duration data in the Year and Source columns.

No.	Species	Site	Country	Sex ratio (% female bias)	Sex ratio (% female bias)			Population size		
				Histological examination	Incubation temperature/duration	Year	Source		Year	Source
1	CM	Sogozu (Yumurtalik)	Turkey	70.5		2012	1	132	2006-2014	2
2	CC	Dalyan	Turkey	55.6	73.5	2010; 1994, 1995, 1996, 2004, 2009, 2010	3; 3-6	240	1995-2010	7,8
3	CC	Fethiye	Turkey	64.7	68	2000-2002; 1996, 2008, 2009	9; 4,6	98	1995-2009	7,10
4	CC	Goksu Delta	Turkey		77	2010	3	112	2004-2008	11
5	CC	Patara	Turkey		70	1995, 2000	3,12	60	1995, 2000	3,12
6	CC	Anamur, Mersin	Turkey	75.5	64.6	2006, 2007	13	790	2006, 2007	13
7	CC	Kizilot	Turkey		96	1995	6	150	1995	6,11

8	CC	Alagadi	North Cyprus		94	1993-1998	14	64	1997-2006	14
9	CM	Alagadi	North Cyprus	97.1	91	1993-1998	15	51	1993-1998	15,16
10	CC	Kefalonia	Greece		59.2	1998	17	33	1998	18
11	CC	Southern Kyparissia	Greece		70	2003	19	451	2003	19
12	CC	Zakynthos	Greece		73	2002, 2003, 2007-2009	20,21	1055	2002, 2003, 2007-2009	20-23
13	CC	Kuriat Islands	Tunisia		5	2013	24	22	2013	24
14	CC	Al-Ghbeba, Al-Thalateen, west of Al-Thalateen, Shash and Al-Arbaeen	Libya		77.9 <sup>1</sup>	2009	25	358	2009	25
15	CM	Poilao SE Bijagos Archipelago	Guinea-Bissau	70		2008, 2009	26	18000	2007	26
16	CC	Boa Vista	Cape Verde Islands		75.6	2005-2008	27	16000	2005-2008	27

17	CC	Santa Luzia	Cape Verde Islands		76.7	2013	28	891	2011, 2012, 2013	28
18	CM	Ascension Island	British Overseas Territory		77	1998-1999, 2006	29,30, 31	16715	1998-1999, 2006	32
19	CC	Baldhead Island, North Carolina	USA		58 <sup>2</sup>	1980-2005, 2010	33	108	1980-2005, 2010	34,35
20	CC	Blackbeard Island, Georgia	USA	67.4		2000-2004	36	227	2006	36
21	CC	Archie Carr Refuge, Florida	USA	93	95.2	1986-1988	37, 38	9000	1986-1988	39
22	CM	Archie Carr Refuge, Florida	USA	81		2011/2012	40	4721	2011/2012	40
23	CC	Hutchinson Island, Florida	USA		96.25	1997	41	6000	1997	41
24	CC	Keewaydin Island, Florida	USA	57.5 <sup>3</sup>		2001-2002, 2004-2006	42	196	2001-2007	42, 43
25	CC	Ten Thousand	USA		50	1991-1994	44	141	1991-1994	44



		Islands, Florida								
26	DC	Sandy Point, St Croix	USA		66.6	2010-2011	45	350.5	2010-2011	46
27	EI	Buck Island, Virgin Islands	USA	94.1		1995	47	135	1995	47
28	EI	Zeelandia Beach, St Eustatius	Caribbean Netherlands		85.9	2015	48	14	2002-2012	48
29	CM	Zeelandia Beach, St Eustatius	Caribbean Netherlands		93.5	2015	48	43	2002-2012	48
30	DC	Zeelandia Beach, St Eustatius	Caribbean Netherlands		91.5	2015	48	9	2002-2012	48
31	DC	Jaragua National Park	Dominican Republic		62.5	2008-2009	49	49	2008-2009	49
32	EI	Mona Island	Puerto Rico		70	2014	50	736	2004-2010	51
33	DC	Pacuare	Costa Rica		90.2	2008	52	3030	2008	52
34	DC	Playa Grande	Costa Rica		86	1993-2012	53, 54,55,56	493	1993-2012	57

35	DC	Tortuguero	Costa Rica		66.9	1990, 1991	58	506	1990, 1991	59
36	CM	Tortuguero	Costa Rica		67	1977	60	10000	1977	61
37	LO	Playa Cuixmala, Jalisco	Mexico		57.4	1994	62	350	1994	62
38	LK	Rancho Nuevo	Mexico		57.5	1994, 2005-2012	63, 64	12716	1994, 2005-2012	63, 64
39	LO	La Escobilla	Mexico	55		2010-2012	65	1160000	2009-2014	66
40	DC	Capitancito, Acandi, Playona	Columbia		91	2005-2007	67	2366	2005-2007	67, 68
41	DC	Matapica beach, Wia-Wia Reserve	Suriname	59.2		1982, 1994	69,70	2960	1970-1993 average	69,70
42	CM	Matapica beach, Wia-Wia Reserve	Suriname	58.85		1982, 1994	69,70	661	1993	69,70
43	CC	Ponta dos Mangues, Sergipe	Brazil		96	89/90 to 91/92, 93/94, 01/02 to 03/04,05/06 to 12/13	71,72,73	106	89/90 to 91/92, 93/94, 01/02 to 03/04,05/06 to 12/13	71,72,73

44	CC	Pirambu, Sergipe	Brazil		97	89/90 to 91/92, 93/94 to 96/97, 98/99,99/00, 01/02, 03/04 to 13/14	71,72,73	243	89/90 to 91/92, 93/94 to 96/97, 98/99,99/00, 01/02, 03/04 to 13/14	71,72, 73
45	CC	Abais, Sergipe	Brazil		92	89/90, 90/91, 93/94, 94/95, 96/97,97/98 02/03, 03/04, 05/06 to 12/13	71,72,73	71	89/90, 90/91, 93/94, 94/95, 96/97,97/9802/03, 03/04, 05/06 to 12/13	71,72, 73
46	CC	Mangue Seco to coqueiro, Bahia	Brazil		92	03/04, 05/06 to 13/14	71,72,73	420	03/04, 05/06 to 13/14	71,72, 73
47	CC	Dunas to Costa Azul, Bahia	Brazil		96	04/05 to 13/14	71,72,73	203	04/05 to 13/14	71,72, 73
48	CC	Siribinha to Ribeiro, Bahia	Brazil		96	94/95 to 96/97, 03/04 to 13/14	71,72,73	728	94/95 to 96/97, 03/04 to 13/14	71,72, 73

49	CC	Baixios to Mamucabo, Bahia	Brazil		93	93/94,97/98, 00/01 to 13/14	71,72,73	902	93/94,97/98, 00/01 to 13/14	71,72, 73
50	CC	Subauma to Porto do Sauipe, Bahia	Brazil		94	89/90 to 91/92, 94/95, 95/96, 97/98,02/03 to 13/14	71,72,73	1029	89/90 to 91/92, 94/95, 95/96, 97/98,02/03 to 13/14	71,72, 73
51	CC	Costa do Sauipe to Imbassai, Bahia	Brazil		95	93/94 to 13/14	71,72,73	1631	93/94 to 13/14	71,72, 73
52	CC	Praia do Forte, Bahia	Brazil		94	89/90 to 13/14	71,72,73	4259	89/90 to 13/14	71,72, 73
53	CC	Itacimirim to Barra do Jacuipe, Bahia	Brazil		92	01/02 to 13/14	71,72,73	1360	01/02 to 13/14	71,72, 73
54	CC	Berta to Arembepe, Bahia	Brazil		89	90/91 to 13/14	71,72,73	1611	90/91 to 13/14	71,72, 73
55	CC	Santa Maria to Busca Vida, Bahia	Brazil		94	89/90 to 13/14	71,72,73	7514	89/90 to 13/14	71,72, 73

56	CC	Itaunas, Espírito Santo	Brazil		69	91/92 to 07/08, 10/11 to 12/13	71,72,73	246	91/92 to 07/08, 10/11 to 12/13	71,72, 73
57	CC	Guriri, Espírito Santo	Brazil		47	89/90 to 08/09, 10/11 to 13/14	71,72,73	360	89/90 to 08/09, 10/11 to 13/14	71,72, 73
58	CC	Pontal do Ipiranga, Espírito Santo	Brazil		66	89/90, 90/91, 92/93 to 00/01, 04/05 to 06/07, 12/13	71,72,73	313	89/90, 90/91, 92/93 to 00/01, 04/05 to 06/07, 12/13	71,72, 73
59	CC	Povoacao, Espírito Santo	Brazil		54	89/90 to 13/14	71,72,73	2005	89/90 to 13/14	71,72, 73
60	CC	Comboios, Espírito Santo	Brazil		57	89/90 to 13/14	71,72,73	2831	89/90 to 13/14	71,72, 73
61	CC	Barra de Itabapoana to Praia do Sul, Rio de Janeiro	Brazil		28	13/14	71,72,73	52	13/14	71,72, 73
62	CC	Ilha de Convivência	Brazil		55	00/01, 01/02,	71,72,73	335	00/01, 01/02, 04/05, 08/09 to 13/14	71,72, 73

		to Açú, Rio de Janeiro				04/05, 08/09 to 13/14				
63	CC	Maria Rosa to Barra do Furado, Rio de Janeiro	Brazil		53	01/02, 03/04 to 13/14	71,72,73	1468	01/02, 03/04 to 13/14	71,72, 73
64	EI	Rio Grande do Norte , Rio de Janeiro	Brazil		88	2003 to 2013	71,72,73	358	2003 to 2013	71,72, 73
65	CM	Diego Garcia	Chagos Islands		33	2012-2014	74	680	2000-2015	75,76
66	EI	Diego Garcia	Chagos Islands		47	2012-2014	74	720	2000-2015	75,76
67	CM	Lanyu	China	68		2010-2011	77	25	2010-2011	77
68	CM	Wan-an	China	93		2010-2011	77	17	2010-2011	77
69	CM	Xiao Liuqiu	China	100		2011	77	100	2011	77
70	LO	Alas Purwo National Park	Java		40	2009-2010	78	103	2009-2010	78
71	DC	Huon Coast	Papua New Guinea		7.7	2007	79	175	2007	79

72	CC	Mon Repos, Queensland	Australia		85	2005-2007; 2009/2010	80,81	356	2005-2007; 2009/2010	80,81, 82
73	ND	Fog Bay, Northern Territory	Australia		76	1997-1998	83	327	1997-1998	83,84
74	EI	Milman Island, Queensland	Australia	75		1991	85	374	1991	85,86
75	CM	Heron Island, Queensland	Australia		85	1998-1999, 2002-2003	87,88	1830	1998/1999, 2002/2003	89,90

Footnotes

<sup>1</sup>Two methods were used to derive sex ratio; the mean value was taken.

<sup>2</sup>An additional study by DeGregorio et al. (91) also supported a strongly female biased population, but quantitative values were not provided.

<sup>3</sup>25-84% female bias was presented in a "mixed" category (both histological and mean incubation temperatures).

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