Life History of Bottomfish Management Unit Species of Guam

DRAFT for WPSAR CIE Review July 8–12, 2024

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EXECUTIVE SUMMARY

Results from the scientific literature and unpublished data were aggregated to document growth, maturity, longevity, and other life history trait values for each Guam Bottomfish Management Unit Species (BMUS). For each species, primary values for all traits were identified that best represent local dynamics. In addition, alternate values were identified that should be considered in sensitivity analyses or as part of an ensemble approach for future stock assessments. Life history data availability varied widely across BMUS. Local life history studies from Guam or other areas of the Mariana Archipelago were available for four species, while no local information was available for six species. When local life history studies were not available, growth data were borrowed from non-local studies if the species could be demonstrated to reach similar lengths in Guam and the study region. Otherwise, StepwiseLH was used to estimate growth trait values. Similarly, maturity values used a mix of local, non-local, and StepwiseLH sources. Longevity values relied mainly on non-local sources and 10 species did not use local maximum ages, either due to a complete lack of local data or the availability of greater estimates from elsewhere that were deemed usable. Taken as a whole, while excellent local values are available for some species, the alternate sources outside of the primary identified sources should be considered during assessment for many of the species, particularly those without local life history studies.

INTRODUCTION

The Bottomfish Management Unit Species (BMUS) of Guam include 13 species of snappers, jacks, and a grouper that are managed in Federal waters by the Western Pacific Regional Fishery Management Council under the Fishery Ecosystem Plan (FEP) for the Mariana Archipelago (FEP; WPRFMC 2009). This report is one of four documents prepared ahead of an external review, to be conducted in July 2024 as part of the Western Pacific Stock Assessment Review (WPSAR), to present data that will be used in benchmark stock assessments of Guam BMUS. Previous stock assessments of the BMUS have been conducted on the entire multi-species complex, most recently in the 2019 benchmark stock assessment (Langseth et al. 2019), which was updated in 2024 (Bohaboy and Matthews, 2024). For the upcoming BMUS benchmark assessment, single-species assessments may be considered. As such, this report describes the life history data available for each individual BMUS, and is accompanied by reports on species-specific catch, catch-per-unit-effort, and length data.

METHODS

This report presents compiled species-level life history information for each BMUS, and identifies the primary (i.e., most reliable) values for each parameter (Table 1) for use in benchmark stock assessments of the Guam BMUS. We do not present estimates of the natural mortality rate, *M*, because *M* can be derived using several empirical estimators based on other life history parameters such as growth, maturity, and longevity (e.g. Jensen 1997, Zhang & Megrey 2006, Then et al. 2015). We will include estimation of *M* and other population dynamics model parameters during the future stages of these benchmark stock assessments.

Table 1. Life history parameters presented in this working paper. Length measurements are in fork length (FL).

Parameter	Units	Definition
L_∞	cm FL	Asymptotic length, for von Bertalanffy growth
k	yr^{-1}	Brody growth coefficient, for von Bertalanffy growth
t_0	yr	Theoretical age at zero length, for von Bertalanffy growth
a	kg * cm^{-b}	Multiplicative coefficient of the length-weight function
b	---	Power coefficient of the length-weight function
L_{50}	cm FL	Length at which 50% of fish have reached maturity
$L_{\Delta 50}$	cm FL	Length at which 50% of fish have changed sex
t_{max}	yr	Maximum possible age

Data Sources

Life History Studies

We searched the scientific literature and unpublished data to document all available information for the life history traits in Table 1 for each BMUS. When necessary, length measurements from published studies were converted to fork length and growth curves were converted to a standardized form of the von Bertalanffy growth function:

$$L(t) = L_\infty * (1 - e^{-k*(t-t_0)})$$

We excluded published studies that were potentially unreliable. First, studies that exclusively aged fish using daily-growth increments, such as by Ralston and Williams (1988), were excluded. This technique tends to underestimate the age of older fish (A.

H. Andrews 2020), and given that all BMUS are relatively long-lived, the results would be biased. Second, we excluded studies that did not age any fish and instead solely used length data to estimate the growth parameters, such as by Brouard and Grandperrin (1985). These studies typically employ analyses such as Electronic Length Frequency Analysis (ELEFAN) and are less reliable than otolith-based methods (Pauly 1987). Lastly, in rare cases where multiple studies were available for a species from the same region, we only reported the most recent study, unless there was reason to believe that the newer study was not a strict improvement over older studies.

StepwiseLH

We used StepwiseLH, a meta-analytical tool, to compile growth, maturity, and longevity estimates for each BMUS. StepwiseLH uses taxonomy and user-input maximum length values to provide life history parameter estimates (Nadon & Ault 2016). We used length measurements from the Guam Biosampling Program (Sundberg et al. 2015) for all BMUS except for *Caranx ignobilis*. *C. ignobilis* is rarely encountered in the Biosampling Program, so we used data from the boat-based creel survey instead (Jasper et al. 2016). We found it was necessary to filter the biosampling data to remove length values that were exceedingly large, and hence were likely data entry or species mis-indentification errors. We assigned maximum length filter limits for *Etelis carbunculus*, *Pristipomoides filamentosus*, *P. flavipinnis*, *P. sieboldii*, and *P. zonatus* based on local life history studies (Table 2). As recommended by Nadon and Ault (2016), we used the 99th percentile length value from the specified survey dataset for each BMUS as the input to StepwiseLH (Table 2).

While StepwiseLH produces estimates of t_{max}, these values were deemed unreliable for BMUS of the genuses *Caranx*, *Etelis*, and *Pristipomoides*. With respect to the *Caranx*, StepwiseLH has not been updated with recent publications that provide increased longevity estimates for several carangids (Pardee et al. 2021), causing StepwiseLH t_{max} values for the family to be unrealistically low. For the *Etelis* and *Pristipomoides*, most of the lutjanid species included in the meta-analysis are shorter-lived, shallower-dwelling species whose longevity is not representative of longer-lived, deeper dwelling BMUS from these two genuses. As with the carangids, this causes StepwiseLH to produce unrealistically low t_{max} values for the *Etelis* and *Pristipomoides*.

Table 2. Maximum length (L_{max}) for each BMUS from survey data (boat-based creel survey for *C. ignobilis*, and biosampling program for all other BMUS) and published life history studies from Guam or elsewhere in Mariana Islands. L_{max} filters are provided for 5 BMUS whose maximum survey length exceeds the local study estimate. The 99th percentile of survey lengths (L_{99}), used as the input to StepwiseLH, are calculated after maximum length filtering of the survey data.

	L_{max}				
	Survey	Study	Source	L_{max} Filter	L_{99}
A. rutilans	97.6	~100	11	---	95.0
C. ignobilis	120.0	---	---	---	118.5
C. lugubris	76.2	---	---	---	68.0
E. carbunculus	76.3	~60	12	60.0	47.2
E. coruscans	95.0	---	---	---	90.4
L. rubioperculatus	45.6	45.6	55	---	34.9
L. kasmira	27.4	---	---	---	25.5
P. auricilla	39.0	40.3	39	---	33.5
P. filamentosus	76.6	65.5	58	65.5	62.6
P. flavipinnis	67.0	~46	24	46.0	44.3
P. sieboldii	63.2	~40	24	41.5	39.2
P. zonatus	57.5	40.4	48	40.8	38.0
V. louti	48.6	53.6	49	---	42.5

Identifying Primary Sources and Parameter Values

Multiple sources were identified for most life history traits for all BMUS. In each case, a primary source that provided the best estimate for that species in Guam was identified. Further sources were then categorized into one of three categories:

- Unusable: Sources that should not be considered in future stock assessments.
- Usable: Sources that can be considered in future stock assessments, but are likely not needed due to the availability of an excellent primary source.
- Alternate: Sources that should be considered in future stock assessments, often due to the lack of an excellent primary source.

Alternate sources are intended to be considered in sensitivity analyses or as part of an ensemble approach in future stock assessments. This is particularly important for species and traits with no local life history information, in which case no single source may accurately capture the species' local dynamics.

Preference was almost always given to local sources when identifying the primary source. Studies conducted throughout the Mariana Archipelago (i.e. Guam and the Commonwealth of the Northern Marianas Islands, CNMI) were considered local. Afterward, studies from regions considered similar to Guam, for example of similar latitude and with a similar maximum length in both regions, were preferred. If no region was similar to Guam, results from StepwiseLH were used as the primary source.

Once the primary source was identified, fixed criteria were used to determine which other sources were usable, whether as an alternate or usable source. These criteria differed according to the life history trait:

- For growth traits (L_∞, k, and t_0), a source was usable if there were no methodological issues (e.g. biased aging techniques or a lack of young fish in samples) and the von Bertalanffy fit was plausible (e.g., study authors did not report concerns regarding parameter estimates and the t_0 estimate was between -2 and 1). The sample size also needed to be at least 40, unless individuals were specifically selected to fill the size range, as is the case for some studies employing radiocarbon aging methods even though it can bias results. Lastly, L_∞ from the source needed to be within 25% of the primary L_∞ estimate. Values outside this range were considered non-representative of local growth patterns.
- For maturity traits (L_{50} and $L_{\Delta 50}$), a source was usable unless immature individuals were missing from the study. No studies were considered unusable due to insufficient sample size. For usable maturity trait sources, an estimate of L_∞ from that region is also provided. Species typically mature at a fixed fraction of their maximum length, as demonstrated by Grimes (1987) for lutjanids, so a non-local L_{50} may need to be scaled to reflect local differences in length.
- For t_{max}, a source was usable if the sample size was at least 40. While sources with such limited sample size may not provide reliable quantitative estimates of t_{max}, they were still included for qualitative comparison with estimates from other regions, which in some cases were lower despite the limited sample size. Estimates from StepwiseLH for carangids were also considered unusable, as explained below.

Unusable sources are still listed for each BMUS because pieces of information from them may still be reliable.

Only a single source was considered across BMUS for the length-weight parameters a and b. These were computed for all species using local paired length-weight data from the biosampling program, following the methods of Kamikawa and others (2015). As this serves as an excellent local source, no other sources were considered.

RESULTS

Life history data availability varied widely across BMUS. High-quality local life history studies from Guam or the CNMI covering growth, maturity, and longevity traits were available for four species. In contrast, no local life history data were available for six species. When usable local studies were not available, growth data were borrowed from non-local studies if the species could be demonstrated to reach similar lengths in Guam and the study region. Otherwise, StepwiseLH was used to provide primary values of growth parameters. Similarly, primary maturity parameter values were identified using a mix of local, non-local, and StepwiseLH sources. Primary longevity values relied more on non-local sources and 10 species did not use local values for t_{max}, either due to a complete lack of local data or the availability of greater estimates from elsewhere that were deemed usable.

Aphareus rutilans

Six growth curves are available for *A. rutilans* and exhibit high regional variation in L_∞. Although the local growth curve from the CNMI has limited sample size (N = 40), its L_∞ is very close to the value obtained through StepwiseLH, which is informed by a large quantity of biosampling lengths when deriving the L_{99} value. We identify the CNMI growth curve as the primary source because it appears appropriate despite the limited sample size. We also identify three alternate growth curves due to potential imprecision in the CNMI growth curve arising from its limited sample size.

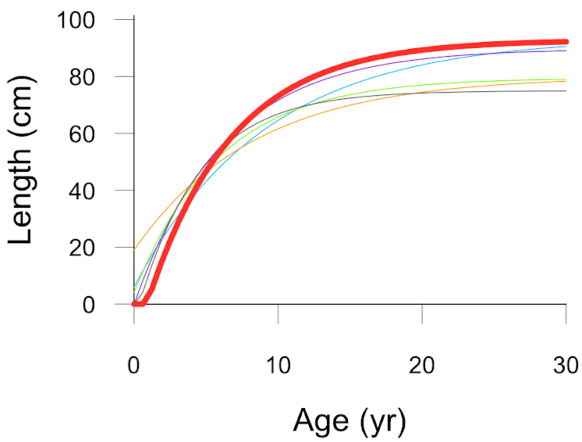

Figure 1. Von Bertalanffy growth curves for *A. rutilans* by region. The primary growth curve is bolded. See Table 3 for additional legend.

Table 3. Von Bertalanffy growth parameters for *A. rutilans*. Primary values are bolded.

Location	Group	L_∞	*k*	t_0	*N*	Usable	Source
StepwiseLH	All	93.8	0.11	-0.6	---	Alternate	34
CNMI	**All**	**92.9**	**0.17**	**0.89**	**40**	**Primary**	**11**
Papua New Guinea	All	89.8	0.16	0	14	No	18
American Samoa	All	80.0	0.12	-2.26	102	No	11
CNMI + AS + MHI	All	79.5	0.17	-0.31	242	Alternate	11
Main Hawaiian Islands	All	75.0	0.23	0.36	100	Alternate	11

StepwiseLH provides the only maturity data for *A. rutilans*. The L_{50} value should be scaled to the L_∞ value from the primary CNMI growth curve, to account for the slight difference in L_∞ between sources.

Table 4. Maturity data for *A. rutilans*. Primary values are bolded.

Location	Sex	L_{50}	L_∞	L_{50} / L_∞	N	Usable	Source
StepwiseLH	**All**	**50.8**	**93.8**	**0.54**	**---**	**Primary**	**34**

Several longevity estimates are available for *A. rutilans*. The local t_{max} value from the CNMI is intermediate at 25 yr, but may be biased downward due to low sample size (N = 40). Given broad similarities between Guam and the Main Hawaiian Islands, we identify the maximal t_{max} value from the Main Hawaiian Islands as the primary value. We identify three alternate sources due to the lack of a well-informed local t_{max} estimate.

Table 5. Longevity data for *A. rutilans* by region. Primary values are bolded.

Location	t_{max}	N	Usable	Source
Main Hawaiian Islands	**34**	**100**	**Primary**	**11**
StepwiseLH	32	---	Alternate	34
CNMI	25	40	Alternate	11
American Samoa	18	102	Alternate	11
Papua New Guinea	16	14	No	18

Outcome: Life history information for *A. rutilans* is of moderate, but usable, quality. Notably and at the time of writing in mid-2024, the Pacific Islands Fisheries Science Center Life History Program is working to analyze more local life history samples and generate local life history information.

Table 6. Primary life history parameter values for *A. rutilans*.

Parameter	Value	SE	Local	Source	Notes
L_∞	92.9	10.3	Yes	11	
k	0.17	0.051	Yes	11	
t_0	0.89	---	Yes	11	
a	0.0255	8.42e-4	Yes	---	From biosampling data
b	2.84	7.65e-3	Yes	---	From biosampling data
L_{50}	50.3	9.4	No	34	StepwiseLH estimate, scaled to selected L_∞
t_{max}	34	3.1	Yes	11	Variance estimated from sample size (Nadon 2017)

Caranx ignobilis

Four growth curves are available for *C. ignobilis* and exhibit high regional variation in L_∞. This variation may reflect indeterminate growth of the species and difficulties in obtaining large *C. ignobilis* specimens in fished regions. For example, A. H. Andrews (2020) recorded a 149.7 cm female caught in the Main Hawaiian Islands, even though the growth curve from the same regions indicates a L_∞ of 107.7 cm (Pardee et al. 2021). Within the Marianas Archipelago, diver surveys (Ayotte et al. 2015) observed a 152.5 cm fish in the remote northern regions of the Mariana Archipelago and the boat-based creel survey recorded a 133.5 cm fish from Guam. We identify the Main Hawaiian Islands growth curve as the primary source given the similar L_{max} values between it and the Mariana Archipelago. We also identify two alternate growth curves that may be appropriate given evidence that outstanding fish can vastly exceed the primary source L_∞.

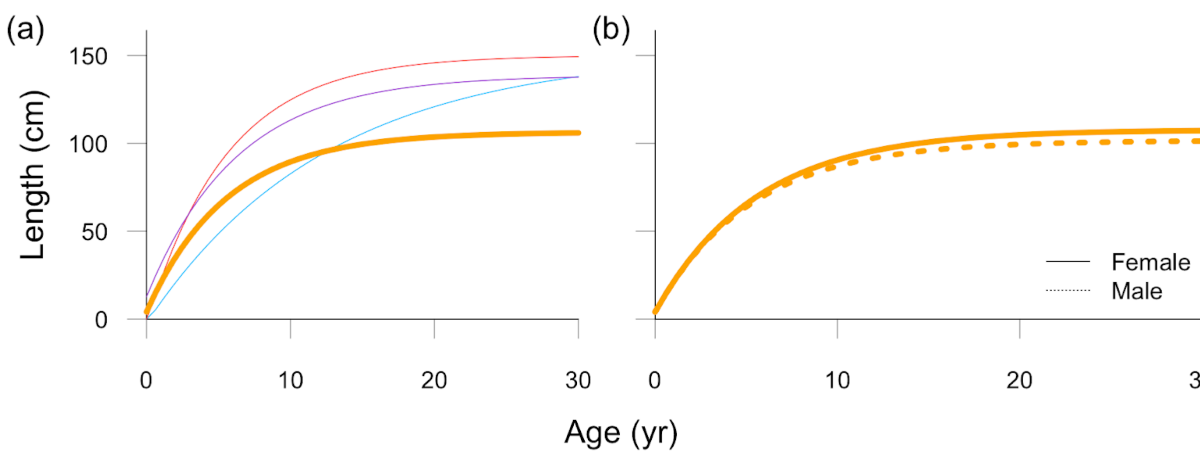

Figure 2. Von Bertalanffy growth curves for *C. ignobilis* (a) by region and (b) by sex within each region, where available. The primary growth curves are bolded. See Table 7 for additional legend.

Table 7. Von Bertalanffy growth parameters for *C. ignobilis*. Primary values are bolded.

Location	Group	L_∞	k	t_0	N	Usable	Source
Gulf of Aden	All	152.0	0.08	0.18	low	No	16
All of Hawaii	All	150	0.18	0.10	17	Alternate	2
StepwiseLH	All	138.7	0.16	-0.6	---	Alternate	34
Main Hawaiian Islands	**All**	**106.4**	**0.18**	**-0.22**	**180**	**Primary**	**41**
	Female	**107.7**	**0.18**	**-0.21**	**86**	**Primary**	**41**
	Male	**101.6**	**0.19**	**-0.22**	**57**	**Primary**	**41**

Maturity data are available to complement the primary growth curve from the Main Hawaiian Islands, and are considered as the primary source. We identify two alternate sources due to the lack of local maturity information.

Table 8. Maturity data for *C. ignobilis*. Primary values are bolded.

Location	Sex	L_{50}	L_∞	L_{50} / L_∞	N	Usable	Source
NWHI	Female	64.3	150	0.43	124	Alternate	52
StepwiseLH	All	69.3	138.7	0.50	---	Alternate	34
Main Hawaiian Islands	**All**	**53.2**	**106.4**	**0.50**	**180**	**Primary**	**41**
	Female	**59.4**	**107.7**	**0.55**	**86**	**Primary**	**41**
	Male	**46.5**	**101.6**	**0.46**	**57**	**Primary**	**41**

The greatest t_{max} and primary value is from the Main Hawaiian Islands, complementing the primary growth and maturity sources.

Table 9. Longevity data for *C. ignobilis*. Primary values are bolded.

Location	t_{max}	N	Usable	Source
Main Hawaiian Islands	**31**	**180**	**Primary**	**41**
StepwiseLH	13	---	No	34
Papua New Guinea	11	1	No	18
New Caledonia	9	Low	No	29

Outcome: No local life history information is available for *C. ignobilis*, but it appears this species exhibits similar dynamics in the Main Hawaiian Islands, from which good sources of growth, maturity, and longevity are available.

Table 10. Primary life history parameter values for *C. ignobilis*.

Parameter		Value	SE	Local	Source	Notes
L_∞ -	All	106.4	1.9	No	41	
	Female	107.7	2.6	No	41	
	Male	101.6	2.9	No	41	
k -	All	0.18	0.010	No	41	
	Female	0.18	0.013	No	41	
	Male	0.19	0.015	No	41	
t_0 -	All	-0.22	---	No	41	
	Female	-0.21	---	No	41	
	Male	-0.22	---	No	41	
a		0.0248	5.61e-4	Yes	---	From biosampling data
b		2.96	7.65e-3	Yes	---	From biosampling data
L_{50} -	All	53.2	1.7	No	41	
	Female	59.4	1.2	No	41	
	Male	46.5	2.9	No	41	
t_{max}		31	3.5	No	41	Variance estimated from sample size (Nadon 2017)

Caranx lugubris

Very little growth data are available for *C. lugubris*, and we identify Stepwise LH as the only usable source.

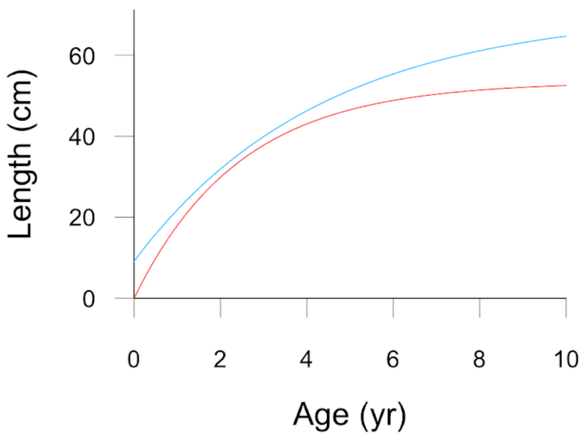

Figure 3. Von Bertalanffy growth curves for *C. lugubris* by region. See Table 11 for additional legend.

Table 11. Von Bertalanffy growth parameters for *C. lugubris*.

Location	Group	L_∞	k	t_0	N	Usable	Source
StepwiseLH	All	70.9	0.23	-0.6	---	Yes	34
Papua New Guinea	All	53.4	0.41	0	12	No	18

StepwiseLH provides the only maturity data for *C. lugubris* and is considered usable to complement the primary growth curve.

Table 12. Maturity data for *C. lugubris*.

Location	Sex	L_{50}	L_∞	L_{50} / L_∞	N	Usable	Source
StepwiseLH	All	39.0	70.9	0.55	---	Yes	34

No usable longevity data are available for *C. lugubris*. Insufficient individuals were sampled in Papua New Guinea to provide a reliable t_{max}, and the StepwiseLH value is likely an underestimate.

Table 13. Longevity data for *C. lugubris* by region.

Location	t_{max}	*N*	Usable	Source
Papua New Guinea	12	12	No	18
StepwiseLH	10	---	No	34

Outcome: Very little life history data are available for *C. lugubris*. While StepwiseLH provides usable growth and maturity data, it does not provide usable longevity data. Taken as a whole, there is not a full set of usable life history values for *C. lugubris*.

Etelis carbunculus

Although numerous life history studies are available for *E. carbunculus*, a cryptic species with much greater maximum length (*E. boweni*) was recently identified (K. R. Andrews et al. 2021). *E. boweni* grows substantially larger than *E. carbunculus*, and available estimates indicate that it may live longer as well (Wakefield et al. 2020). This discredits many of the older studies that may have intermixed the two species, and only studies which specifically differentiate *E. carbunculus* from *E. boweni* or are outside the range of *E. boweni* (e.g., the Hawaiian Island Archipelago) are considered.

Six growth curves are available for *E. carbunculus*, none of which are local. L_∞ is similar across the Pacific Ocean locations, although it appears *E. carbunculus* does not grow as large in the Indian Ocean. Notably, males reach smaller maximum length than females across most of the studies. Difficulties are encountered when estimating L_{99} for the StepwiseLH growth curve, as different sources indicate noticeably different values. For this reason, the StepwiseLH growth curve should be used with caution. L_{max} in Guam is reported to be about 60 cm (Dahl et al. 2024), which is similar to the value from the Main and Northwest Hawaiian Islands once outliers at 71.0 and 65.8 cm are removed (Nichols 2019). We identify the growth curve for all of Hawaii as the primary source, given that differences between the Main and Northwest Hawaiian Islands values are minor and it improves the data available to estimate L_∞. We identify four alternate sources due to the lack of local growth information.

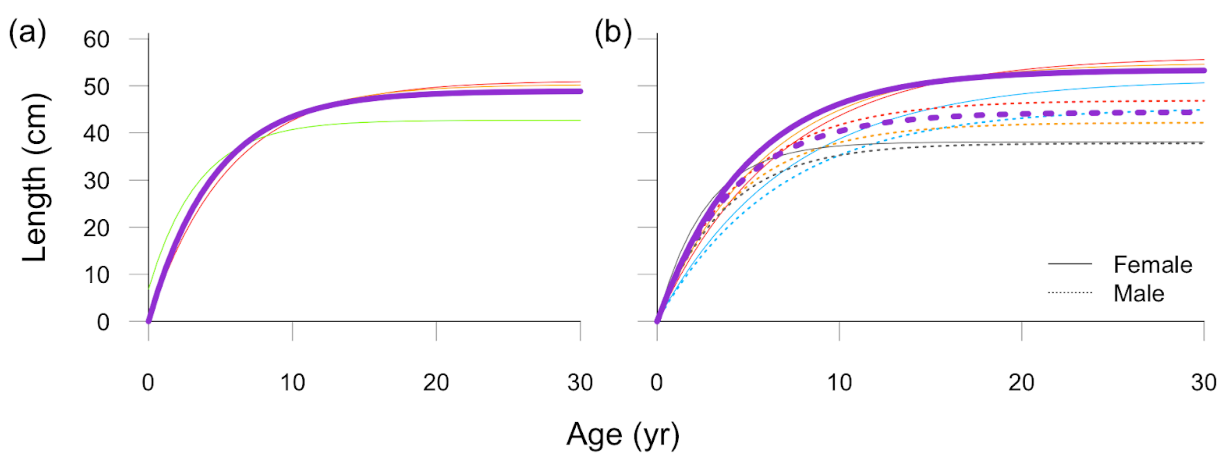

Figure 4. Von Bertalanffy growth curves for *E. carbunculus* (a) by region and (b) by sex within each region, where available. The primary growth curves are bolded. See Table 14 for additional legend.

Table 14. Von Bertalanffy growth parameters for *E. carbunculus*. Primary values are bolded.

Location	Group	L_∞	k	t_0	N	Usable	Source
South Pacific	Female	51.4	0.14	0	195	Alternate	63
	Male	45.4	0.15	0	106	Alternate	63
NW Hawaiian Islands	All	51.1	0.18	0	138	Alternate	36
	Female	56.2	0.15	0	81	Alternate	36
	Male	46.9	0.22	0	58	Alternate	36
All of Hawaii	**All**	**48.9**	**0.22**	**0**	**621**	**Primary**	**36, 51**
	Female	**53.4**	**0.20**	**0**	**348**	**Primary**	**36, 51**
	Male	**44.4**	**0.24**	**0**	**254**	**Primary**	**36, 51**
Main Hawaiian Islands	All	50.3	0.20	0	343	Alternate	36
	Female	54.9	0.17	0	186	Alternate	36
	Male	42.2	0.23	0	141	Alternate	36
StepwiseLH	All	42.7	0.29	-0.6	---	Alternate	34
East Indian	Female	38.1	0.38	0	36	No	63
	Male	37.8	0.27	0	29	No	63

Maturity data are available from the Main and Northwest Hawaiian Islands to complement the primary growth curve from all of Hawaii. We recommend using values for unfished NW Hawaiian Islands, because we do not want to introduce assumptions regarding fishing-induced changes to *E. carbunculus* reproductive biology that would accompany using parameter values from the fished areas of the Main Hawaiian Islands. We identify two alternate sources due to the lack of local maturity information.

Table 15. Maturity data for *E. carbunculus*. Primary values are bolded.

Location	Sex	L_{50}	L_∞	L_{50} / L_∞	N	Usable	Source
NW Hawaiian Islands	**Female**	**27.2**	**56.2**	**0.48**	**194**	**Primary**	**13, 36**
StepwiseLH	All	27.1	42.7	0.63	---	Alternate	34
Main Hawaiian Islands	Female	23.4	54.9	0.43	215	Alternate	13, 36

Usable longevity estimates for *E. carbunculus* range from 22 to 33 yr, with the Northwest Hawaiian Islands providing the maximum value. Note that the Main Hawaiian Islands provide a lower estimate of 22 yr, which likely reflects the impact of fishing mortality rather than a real difference in longevity. Given the use of information from Hawaii for growth and maturity, we identify this maximum value of 33 as the primary value. We identify three alternate sources due to the lack of local longevity information.

Table 16. Longevity data for *E. carbunculus*. Primary values are bolded.

Location	t_{max}	*N*	Usable	Source
NW Hawaiian Islands	**33**	**192**	**Primary**	**36**
East Indian	33	65	Alternate	63
South Pacific	32	301	Alternate	63
Main Hawaiian Islands	22	495	Alternate	36
StepwiseLH	20	---	No	34

Outcome: No local life history information is available for *E. carbunculus*, but it appears that the species exhibits similar dynamics in Hawaii, from which good sources of growth, maturity, and longevity are available.

Table 17. Primary life history parameter values for *E. carbunculus*.

Parameter		Value	SE	Local	Source	Notes
L_∞ -	All	48.9	0.48	No	36, 51	
	Female	53.4	0.65	No	36, 51	
	Male	44.4	0.58	No	36, 51	
k -	All	0.22	5.78e-3	No	36, 51	
	Female	0.20	5.95e-3	No	36, 51	
	Male	0.24	9.21e-3	No	36, 51	
t_0 -	All	0	---	No	36, 51	
	Female	0	---	No	36, 51	
	Male	0	---	No	36, 51	
a		0.0162	4.85e-4	Yes	---	From biosampling data
b		3.02	7.65e-3	Yes	---	From biosampling data
L_{50} -	Female	27.2	1.12	No	13	
t_{max}		33	1.8	No	36	Variance estimated from sample size (Nadon 2017)

Etelis coruscans

Five growth curves are available for *E. coruscans*, none of which is local. The maximum length recorded in the Guam biosampling data is 95.0 cm, which is similar to the Main Hawaiian Islands value of 97.0 cm (Reed et al. 2023). For this reason, we identify the Main Hawaiian Islands growth curve as the primary source. We identify three alternate sources due to the lack of local growth information.

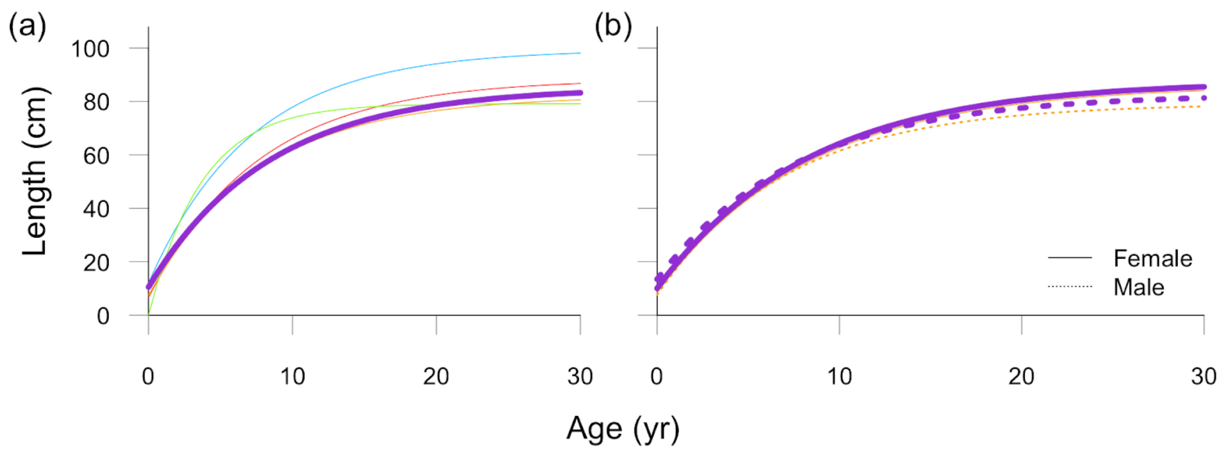

Figure 5. Von Bertalanffy growth curves for *E. coruscans* (a) by region and (b) by sex within each region, where available. The primary growth curves are bolded. See Table 18 for additional legend.

Table 18. Von Bertalanffy growth parameters for *E. coruscans*. Primary values are bolded.

Location	Group	L_∞	k	t_0	N	Usable	Source
New Caledonia	All	99.4	0.14	-0.93	79	Alternate	61
StepwiseLH	All	88.4	0.13	-0.6	---	Alternate	34
Main Hawaiian Islands	**All**	**85.3**	**0.12**	**-1.10**	**187**	**Primary**	**3**
	Female	**87.6**	**0.12**	**-1.02**	**114**	**Primary**	**3**
	Male	**82.7**	**0.13**	**-1.37**	**102**	**Primary**	**3**
Okinawa	All	82.1	0.13	-0.74	749	Alternate	57
	Female	86.2	0.12	-0.85	417	Alternate	57
	Male	79.2	0.14	-0.72	351	Alternate	57
Papua New Guinea	All	79.2	0.27	0	6	No	18

Local maturity data are available for *E. coruscans*, and are considered as the primary source.

Table 19. Maturity data for *E. coruscans*. Primary values are bolded.

Location	Sex	L_{50}	L_{∞}	L_{50} / L_{∞}	*N*	Usable	Source
Okinawa	Female	67.1	86.2	0.78	324	Yes	56
	Male	37.6	79.2	0.47	292	Yes	56
Main Hawaiian Islands	Female	65.8	87.6	0.75	149	Yes	3, 46
Guam	**Female**	**58.4**	**---**	**---**	**202**	**Primary**	**47**
StepwiseLH	All	48.5	88.4	0.55	---	Yes	34

Usable longevity estimates for *E. coruscans* range from 18 to 55 yr, though none is local. The estimate from the primary growth source of the Main Hawaiian Islands is 55 yr. Given that the value from Okinawa is also 55 yr, we identify the maximum value of 55 yr as the primary value. We identify three alternate sources due to the lack of local longevity information.

Table 20. Longevity data for *E. coruscans*. Primary values are bolded.

Location	t_{max}	*N*	Usable	Source
Main Hawaiian Islands	**55**	**188**	**Primary**	**3**
Okinawa	55	749	Alternate	57
South Pacific	40	165	Alternate	62
StepwiseLH	30	---	No	34
Papua New Guinea	20	6	No	18
New Caledonia	18	79	Alternate	61

Outcome: Although no local life history information is available for *E. coruscans* except for maturity data, it appears the species exhibits similar dynamics in the Main Hawaiian Islands, from which good sources of growth and longevity information are available.

Table 21. Primary life history parameter values for *E. coruscans*.

Parameter		Value	SE	Local	Source	Notes
L_∞ -	All	85.3	1.0	No	3	
	Female	87.6	1.2	No	3	
	Male	82.7	1.4	No	3	
k -	All	0.12	0.006	No	3	
	Female	0.12	0.007	No	3	
	Male	0.13	0.008	No	3	
t_0 -	All	-1.10	0.19	No	3	
	Female	-1.02	0.21	No	3	
	Male	-1.37	0.26	No	3	
a		0.0387	2.40e-3	Yes	---	From biosampling data
b		2.77	0.0153	Yes	---	From biosampling data
L_{50} -	Female	58.4	1.1	Yes	47	
t_{max}		55	3.1	No	3	Variance estimated from sample size (Nadon 2017)

Lethrinus rubrioperculatus

Five growth curves are available for *L. rubrioperculatus* and exhibit high regional variation in L_∞. Although local growth curves are available, they are not usable and the *k* values are not reliable due to issues with the aging of sub-yearling fish (Trianni 2011). This may not preclude use of the local L_∞ values, and StepwiseLH gives a similar L_∞ estimate. For this reason and given the substantial biosampling data used to inform the StepwiseLH values, we identify StepwiseLH as the primary source. We identify two alternate sources due to the lack of usable local growth information.

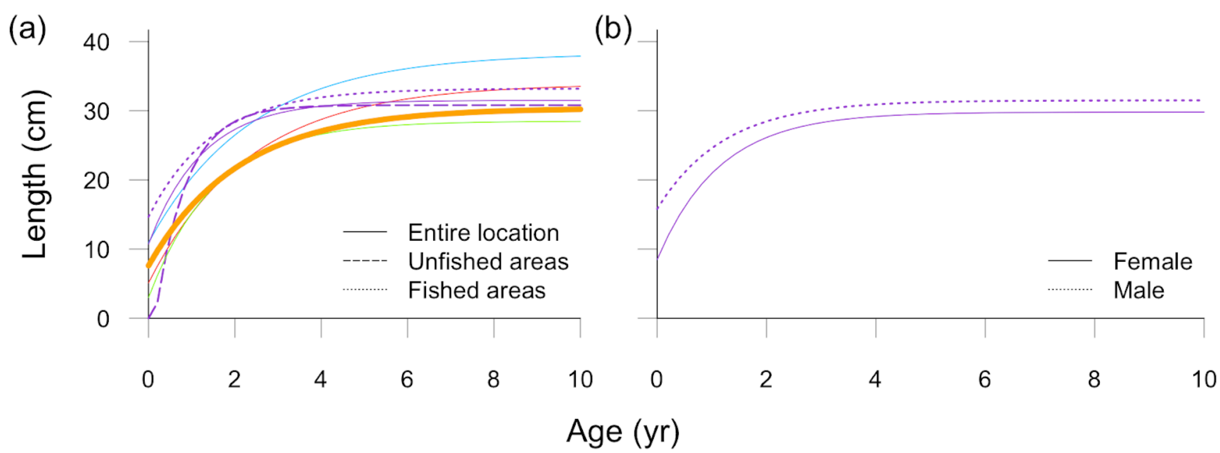

Figure 6. Von Bertalanffy growth curves for *L. rubrioperculatus* (a) by region and, where available, unfished and fished areas within each region, and (b) by sex within each region, where available. The primary growth curve is bolded. See Table 22 for additional legend.

Table 22. Von Bertalanffy growth parameters for *L. rubrioperculatus*. Primary values are bolded.

Location	Group	L_∞	k	t_0	N	Usable	Source
Okinawa	All	38.3	0.42	-0.8	635	No	15
New Caledonia	All	33.9	0.43	-0.38	499	Alternate	29
CNMI	All	31.5	0.8	-0.52	286	No	55
	Female	29.8	0.88	-0.38	193	No	55
	Male	31.5	0.82	-0.85	89	No	55
	Unfished	30.8	1.39	0.15	161	No	55
	Fished	33.2	0.67	-0.87	125	No	55
StepwiseLH	**All**	**30.4**	**0.48**	**-0.6**	**---**	**Primary**	**34**

American Samoa	All	28.5	0.65	-0.17	114	Alternate	40

L. rubrioperculatus is a monandric protogynous hermaphrodite (Ebisawa 1997), meaning individuals initially mature as female and may then transition to male. Despite issues with the local source for growth data, local L_{50} and $L_{\Delta 50}$ estimates should still be usable and are identified as the primary values. We recommend using values for unfished areas of the CNMI, because we do not want to introduce assumptions regarding fishing-induced changes to *L. rubrioperculatus* reproductive biology that would accompany using parameter values from the fished areas of CNMI. However, we note that L_{50} and $L_{\Delta 50}$ values, both in isolation and as a fraction of L_∞, are quite similar between fished and unfished areas.

Table 23. Maturity data for *L. rubrioperculatus*. Primary values are bolded.

Location	Sex	L_{50}	$L_{\Delta 50}$	L_∞	L_{50} / L_∞	*N*	Usable	Source
New Caledonia	All	23.7	---	33.9	0.70	499	Yes	29
StepwiseLH	All	23.5	---	30.4	0.77	---	Yes	34
CNMI (fished)	All	23.2	29.0	33.2	0.70	421	Yes	55
Okinawa	All	~22	~34	38.3	0.57	386	Yes	14, 15
CNMI (unfished)	**All**	**21.9**	**29.2**	**30.8**	**0.71**	**505**	**Primary**	**55**
American Samoa	All	20.4	---	28.5	0.72	---	No	40

The local estimate of t_{max} (8 yr) is the lowest among sources. Given similarly higher estimates from Okinawa, New Caledonia, and StepwiseLH, we identify the maximum value of 15 yr from New Caledonia as the primary value. We also identify five alternate sources due to differences between the primary and local estimates.

Table 24. Longevity data for *L. rubrioperculatus*. Primary values are bolded.

Location	t_{max}	*N*	Usable	Source
New Caledonia	**15**	**499**	**Primary**	**29**
StepwiseLH	14	---	Alternate	34
Okinawa	13	635	Alternate	15
Great Barrier Reef	11	unsp.	Alternate	28
American Samoa	10	114	Alternate	40
CNMI	8	286	Alternate	55

Outcome: Life history information for *L. rubrioperculatus* is of moderate, but usable, quality.

Table 25. Primary life history parameter values for *L. rubrioperculatus*. Standard errors marked with '*' are provided in log-space, as the corresponding parameter is lognormally distributed.

Parameter	Value	SE	Local	Source	Notes
L_∞	30.4	1.6	No	34	StepwiseLH estimate
k	0.48	0.45*	No	34	StepwiseLH estimate
t_0	-0.6	---	No	34	StepwiseLH estimate
a	0.0246	6.38e-4	Yes	---	From biosampling data
b	2.92	7.65e-3	Yes	---	From biosampling data
L_{50}	20.1	0.40	Yes	55	Scaled to selected L_∞
$L_{\Delta 50}$	26.7	0.19	Yes	55	Scaled to selected L_∞
t_{max}	15	0.84	No	29	Variance estimated from sample size (Nadon 2017)

Lutjanus kasmira

Five growth curves are available for *L. kasmira* and exhibit high regional variation in L_∞. No local growth curve is available, and it appears this species attains much larger size in the Main Hawaiian Islands and Red Sea than in Guam. Given the substantial biosampling data used to inform the StepwiseLH values and issues with the New Caledonia and American Samoa sources that make them unusable, we identify StepwiseLH as the primary source.

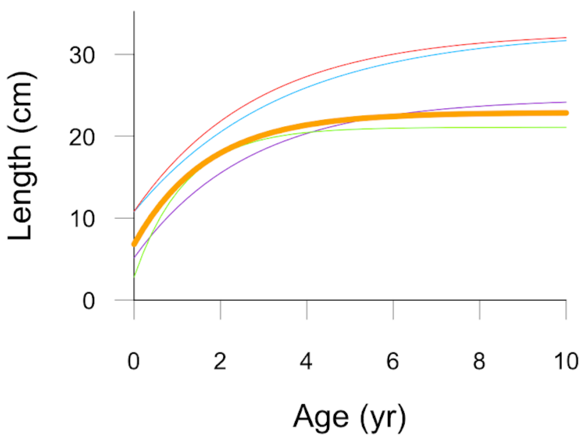

Figure 7. Von Bertalanffy growth curves for *L. kasmira* by region. The primary growth curve is bolded. See Table 26 for additional legend.

Table 26. Von Bertalanffy growth parameters for *L. kasmira*. Primary values are bolded.

Location	Group	L_∞	k	t_0	N	Usable	Source
Main Hawaiian Islands	All	32.9	0.29	-1.37	171	No	33
Red Sea	All	32.7	0.35	-1.15	714	No	7
New Caledonia	All	24.6	0.38	-0.62	21	No	29
StepwiseLH	**All**	**22.9**	**0.59**	**-0.6**	**---**	**Primary**	**34**
American Samoa	All	21.1	0.84	-0.17	270	No	38

No local maturity data are available for *L. kasmira*. Maturity data are available from three non-local sources, but given the substantial regional variation in L_∞ and use of StepwiseLH for primary growth values, we identify StepwiseLH as the primary source for maturity data. We identify two alternate sources due to the lack of local maturity information.

Table 27. Maturity data for *L. kasmira*. Primary values are bolded.

Location	Sex	*L50*	L_∞	L_{50} / L_∞	*N*	Usable	Source
Red Sea	All	19.0	32.7	0.58	714	Alternate	7
Andaman Sea	All	19	---	---	792	Alternate	45
StepwiseLH	**All**	**17.5**	**22.9**	**0.77**	**---**	**Primary**	**34**

No local longevity data are available for *L. kasmira*, and four usable non-local sources provide a range of t_{max} values from 5 to 13. Both StepwiseLH and longevity data from American Samoa agree on an estimated t_{max} of 13 yr, which we select as the primary value. We identify three alternate sources due to the lack of local longevity information.

Table 28. Longevity data for *L. kasmira*. Primary values are bolded.

Location	t_{max}	*N*	Usable	Source
American Samoa	**13**	**270**	**Primary**	**38**
StepwiseLH	13	---	Alternate	34
New Caledonia	8	21	No	29
Main Hawaiian Islands	6	171	Alternate	33
Papua New Guinea	6	2	No	18
Red Sea	5	714	Alternate	7

Outcome: No local life history information is available for *L. kasmira*, and StepwiseLH provides most of the primary values.

Table 29. Primary life history parameter values for *L. kasmira*. Standard errors marked with ‘*’ are provided in log-space, as the corresponding parameter is lognormally distributed.

Parameter	Value	SE	Local	Source	Notes
L_∞	22.9	2.3	No	34	StepwiseLH estimate
k	0.59	0.44*	No	34	StepwiseLH estimate
t_0	-0.6	---	No	34	StepwiseLH estimate
a	0.0175	1.17e-3	Yes	---	From biosampling data
b	3.01	0.0230	Yes	---	From biosampling data
L_{50}	17.5	2.7	No	34	StepwiseLH estimate

t_{max}	13	0.96	No	38	Variance estimated from sample size (Nadon 2017)

Pristipomoides auricilla

Only two growth curves are available for *P. auricilla*, but one is from a high quality study using local data and is identified as the primary source. We recommend using the growth curve from unfished areas, because our objective is to quantify the intrinsic biology of the species, independently from the effects of population length or age truncation that commonly occur in fished populations. The only other source of growth information is from StepwiseLH, which is unlikely to offer any improvement over the local growth curve.

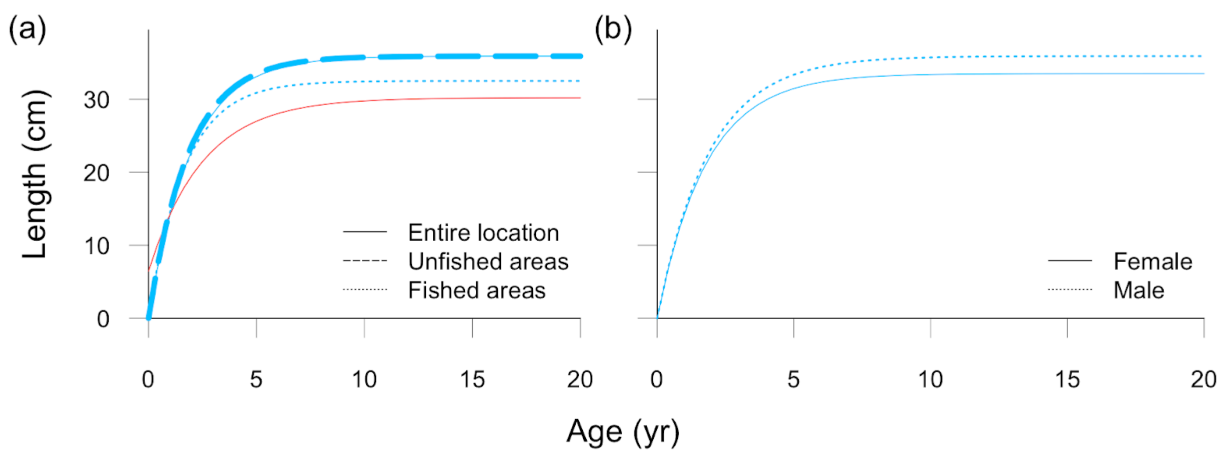

Figure 8. Von Bertalanffy growth curves for *P. auricilla* (a) by region and, where available, unfished and fished areas within each region, and (b) by sex within each region, where available. The primary growth curve is bolded. See Table 30 for additional legend.

Table 30. Von Bertalanffy growth parameters for *P. auricilla*. Primary values are bolded.

Location	Group	L_∞	k	t_0	N	Usable	Source
Mariana Archipelago	All	35.9	0.51	0	295	Yes	39
	Female	33.5	0.56	0	106	Alternate	39
	Male	35.9	0.53	0	160	Alternate	39
	Unfished	**35.9**	**0.54**	**0**	**160**	**Primary**	**39**
	Fished	32.5	0.6	0	135	Yes	39
StepwiseLH	All	30.2	0.40	-0.6	---	Yes	34

There are only three sources of maturity data for *P. auricilla*, two of which are local. We identify the Guam-specific source as primary.

Table 31. Maturity data for *P. auricilla*. Primary values are bolded.

Location	Sex	L_{50}	L_{∞}	L_{50} / L_{∞}	N	Usable	Source
Guam	**Female**	**24.5**	**33.5**	**0.73**	**104**	**Primary**	**39, 51**
Mariana Archipelago	Female	23.7	33.5	0.71	229	Yes	39, 51
StepwiseLH	All	21.1	30.2	0.70	---	Yes	34

Local longevity data are available for *P. auricilla*, with fish living much longer in the unfished areas of the Mariana Archipelago than the fished areas. An apparent lack of older individuals in the fished areas is expected because fish are likely to be harvested before reaching advanced ages. For this reason, we identify the Mariana-wide maximum of 32 yr as the primary value.

Table 32. Longevity data for *P. auricilla*. Primary values are bolded.

Location	t_{max}	N	Usable	Source
Marianas (unfished)	**32**	**160**	**Primary**	**39**
Marianas (fished)	18	135	Yes	39
StepwiseLH	16	---	No	34
Papua New Guinea	7	4	No	18

Outcome: Excellent local life history data are available for *P. auricilla*.

Table 33. Primary life history parameter values for *P. auricilla*.

Parameter	Value	SE	Local	Source	Notes
L_{∞}	35.9	0.26	Yes	39	
k	0.54	0.023	Yes	39	
t_0	0	---	Yes	39	
a	9.92e-3	1.84e-4	Yes	---	From biosampling data
b	3.20	5.10e-3	Yes	---	From biosampling data
L_{50} - Female	24.5	0.5	Yes	51	
t_{max}	32	2.4	Yes	39	Variance estimated from sample size (Nadon 2017)

Pristipomoides filamentosus

Seven growth curves are available for *P. filamentosus* and exhibit high regional variation in L_∞. Fortunately, a local growth curve is available and is selected as the primary source. Although separate local growth curves are available for unfished and fished areas, there is no substantial difference between them. For this reason, we select the growth curve aggregated across the Mariana Archipelago as the primary growth curve.

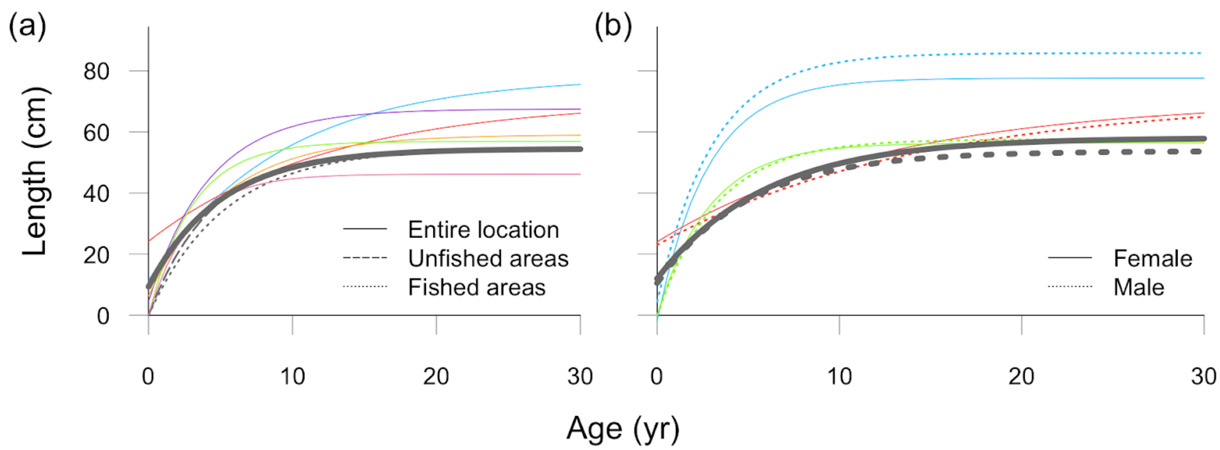

Figure 9. Von Bertalanffy growth curves for *P. filamentosus* (a) by region and, where available, unfished and fished areas within each region, and (b) by sex within each region, where available. The primary growth curves are bolded. See Table 34 for additional legend.

Table 34. Von Bertalanffy growth parameters for *P. filamentosus*. Primary values are bolded.

Location	Group	L_∞	k	t_0	N	Usable	Source
Seychelles	All	78.0	0.11	-1.44	85	No	1, 43
	Female	77.6	0.36	0.06	unsp.	No	21
	Male	85.8	0.33	-0.16	unsp.	No	21
Okinawa	All	70.3	0.08	-5.28	303	No	57
	Female	70.4	0.08	-5.22	162	No	57
	Male	70.8	0.07	-5.61	134	No	57
NW Hawaiian Islands	All	67.5	0.24	-0.29	36	Yes	1
StepwiseLH	All	59.1	0.19	-0.6	---	Yes	34
Main Hawaiian Islands	All	56.9	0.33	0	377	Yes	37

	Female	56.4	0.35	0	202	Yes	37
	Male	57.6	0.31	0	175	Yes	37
Mariana Archipelago	**All**	**54.5**	**0.20**	**-0.94**	**217**	**Yes**	**58**
	Female	**58.1**	**0.17**	**-1.36**	**83**	**Alternate**	**58**
	Male	**53.7**	**0.20**	**-1.09**	**127**	**Alternate**	**58**
	Unfished	54.5	0.23	0	122	Primary	58
	Fished	54.6	0.19	0	95	Yes	58
Papua New Guinea	All	46.2	0.34	0	43	Yes	18

Five sources of maturity data are available for *P. filamentosus*, again including a local source that is identified as the primary source.

Table 35. Maturity data for *P. filamentosus*. Primary values are bolded.

Location	Sex	L_{50}	L_∞	L_{50} / L_∞	N	Usable	Source
Main Hawaiian Islands	Female	40.7	56.4	0.72	479	Yes	30, 37
	Male	34.3	57.6	0.60	419	Yes	30, 37
StepwiseLH	All	34.7	59.1	0.59	---	Yes	34
Papua New Guinea	All	34.0	60.9	0.56	94	Yes	27
Mariana Archipelago	**All**	**32.6**	**54.5**	**0.60**	**254**	**Primary**	**58**
	Female	**41.2**	**58.1**	**0.71**	**111**	**Primary**	**58**
	Male	**27.6**	**53.7**	**0.51**	**143**	**Primary**	**58**
Okinawa	Female	35.7	70.4	0.51	110	Yes	56, 57
	Male	≤ 20.0	70.8	≤ 0.28	88	No	56, 57

Many longevity sources are available for *P. filamentosus*, with t_{max} values ranging from 30 to 64 yr from usable sources. The local estimate is relatively low, at 31 yr. Given the broad similarities between Guam and the Main Hawaiian Islands identified for several BMUS, we select the greater t_{max} estimate of 50 yr from the Main Hawaiian Islands as the primary value. We also identify five alternate sources due to differences between the primary and local estimates.

Table 36. Longevity data for *P. filamentosus*. Primary values are bolded.

Location	t_{max}	*N*	Usable	Source
South Pacific	64	85	Alternate	62
Main Hawaiian Islands	**50**	**399**	**Primary**	**37**
NW Hawaiian Islands	43	43	Alternate	1
Okinawa	35	303	Alternate	57
Mariana Archipelago	31	217	Alternate	58
Seychelles	30	242	Alternate	43
StepwiseLH	24	---	No	34
Papua New Guinea	12	43	No	18

Outcome: A large amount of life history information is available for *P. filamentosus*, including a local source that contributes most of the primary values.

Table 37. Primary life history parameter values for *P. filamentosus*.

Parameter		Value	SE	Local	Source	Notes
L_∞ -	All	54.5	1.3	Yes	58	
	Female	58.1	2.9	Yes	58	
	Male	53.7	1.5	Yes	58	
k -	All	0.20	0.030	Yes	58	
	Female	0.17	0.038	Yes	58	
	Male	0.20	0.037	Yes	58	
t_0 -	All	-0.94	0.56	Yes	58	
	Female	-1.36	0.94	Yes	58	
	Male	-1.09	0.69	Yes	58	
a		0.0252	1.15e-3	Yes	---	From biosampling data
b		2.90	0.0128	Yes	---	From biosampling data
L_{50} -	All	32.6	0.68	Yes	58	Variance estimated from sample size (Nadon 2017)
	Female	41.2	1.3	Yes	58	"
	Male	27.6	1.0	Yes	58	"

t_{max}	50	2.8	No	37	Variance estimated from sample size (Nadon 2017)

Pristipomoides flavipinnis

Three growth curves are available for *P. flavipinnis*, none of which is local. L_{max} in Guam from a 1973 study by Kami is about 46 cm, which is similar to Samoa Archipelago values of 45.3 cm for fished areas and 47.4 cm for unfished areas (O'Malley et al. 2019). For this reason we identify the Samoa Archipelago as the primary source, in particular the growth curve for unfished areas because our objective is to quantify the intrinsic biology of the species, independently from the effects of population length or age truncation that commonly occur in fished populations. We identify an alternate source due to the lack of local growth information.

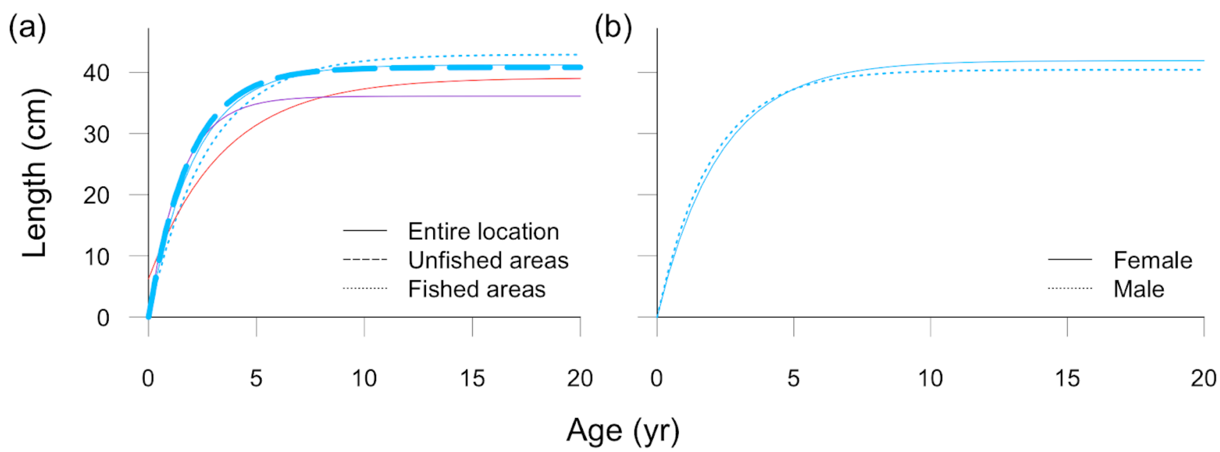

Figure 10. Von Bertalanffy growth curves for *P. flavipinnis* (a) by region and, where available, unfished and fished areas within each region, and (b) by sex within each region, where available. The primary growth curve is bolded. See Table 38 for additional legend.

Table 38. Von Bertalanffy growth parameters for *P. flavipinnis*. Primary values are bolded.

Location	Group	L_∞	k	t_0	N	Usable	Source
Samoa Archipelago	All	41.2	0.47	0	373	Yes	39
	Female	41.9	0.44	0	179	Yes	39
	Male	40.4	0.51	0	194	Yes	39
	Unfished	**40.8**	**0.53**	**0**	**312**	**Primary**	**39**
	Fished	42.9	0.37	0	61	Yes	39
StepwiseLH	All	39.1	0.29	-0.6	---	Alternate	34
Papua New Guinea	All	36.1	0.67	0	14	No	18

StepwiseLH provides the only maturity data for *P. flavipinnis*. The L_{50} value should be scaled to the L_∞ value from the primary Samoa Archipelago growth curve, to account for the difference in L_∞ between sources.

Table 39. Maturity data for *P. flavipinnis*. Primary values are bolded.

Location	Sex	L_{50}	L_∞	L_{50} / L_∞	N	Usable	Source
StepwiseLH	**All**	**25.2**	**39.1**	**0.64**	**---**	**Primary**	**34**

Two usable sources of longevity data are available for *P. flavipinnis*, offering estimates of 10 and 28 yr from the unfished and fished areas of the Samoa Archipelago, respectively. We identify the Samoa-wide maximum of 28 yr as the primary value. We identify the fished estimate as alternate due to the lack of local longevity information.

Table 40. Longevity data for *P. flavipinnis*. Primary values are bolded.

Location	t_{max}	N	Usable	Source
Samoas (unfished)	**28**	**312**	**Primary**	**39**
StepwiseLH	20	---	No	34
Papua New Guinea	11	14	No	18
Samoas (fished)	10	61	Alternate	39

Outcome: Although no local life history information is available for *P. flavipinnis*, it appears species biology is likely similar between Guam and Samoa Archipelago, from which good sources of growth and longevity are available.

Table 41. Primary life history parameter values for *P. flavipinnis*.

Parameter	Value	SE	Local	Source	Notes
L_∞	42.9	0.18	No	39	
k	0.37	0.020	No	39	
t_0	0	---	No	39	
a	0.0170	5.87e-4	Yes	---	From biosampling data
b	3.02	0.0102	Yes	---	From biosampling data
L_{50}	27.6	6.3	No	34	StepwiseLH estimate, scaled to selected L_∞

t_{max}	28	2.1	No	39	Variance estimated from sample size (Nadon 2017)

Pristipomoides sieboldii

Only two growth curves are available for *P. sieboldii*, neither of which is local. Furthermore, the Okinawa growth curve is not usable due to large negative t_0 values. The StepwiseLH growth curve is still considered usable as the primary source given the local length data used to inform it.

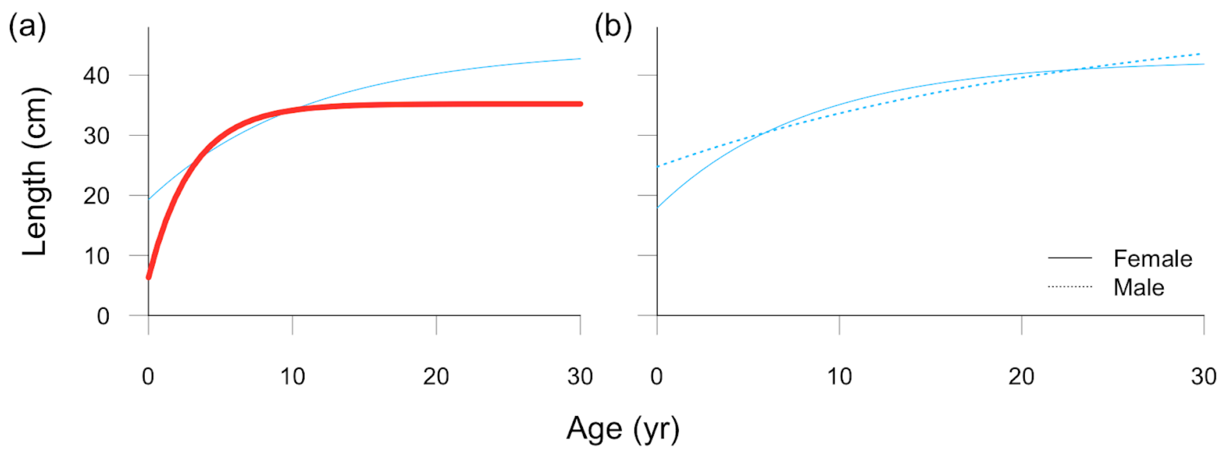

Figure 11. Von Bertalanffy growth curves for *P. sieboldii* (a) by region and (b) by sex within each region, where available. The primary growth curve is bolded. See Table 42 for additional legend.

Table 42. Von Bertalanffy growth parameters for *P. sieboldii*. Primary values are bolded.

Location	Group	L_∞	k	t_0	N	Usable	Source
Okinawa	All	44.4	0.09	-6.33	374	No	57
	Female	42.5	0.12	-4.55	275	No	57
	Male	51.7	0.04	-16.28	93	No	57
StepwiseLH	**All**	**35.2**	**0.33**	**-0.6**	**---**	**Primary**	**34**

Four sources of maturity data are available for *P. sieboldii*, although none is local. One is from the Main Hawaiian Islands, which serves as a good alternate source of data for several BMUS. In this case, StepwiseLH provides a similar L_{50} estimate to that from the Main Hawaiian Islands, which lends confidence to the values. For this reason and given the choice of StepwiseLH as the primary growth data source, we identify StepwiseLH as the primary maturity data source. We identify three alternate sources due to the lack of local maturity information.

Table 43. Maturity data for *P. sieboldii*. Primary values are bolded.

Location	Sex	L_{50}	L_∞	L_{50} / L_∞	N	Usable	Source
NW Hawaiian Islands	Female	28.6	---	---	83	Alternate	13
Okinawa	Female	24.6	42.5	0.58	226	Alternate	56, 57
	Male	≤ 24.0	51.7	≤ 0.46	94	No	56, 57
Main Hawaiian Islands	Female	23.8	---	---	198	Alternate	13
StepwiseLH	**All**	**23.7**	**35.2**	**0.67**	**---**	**Primary**	**34**

Longevity data are only available for *P. sieboldii* from Okinawa and StepwiseLH, which provide widely different estimates (t_{max} = 38 and 18 years for Okinawa and StepwiseLH, respectively). We select the greater t_{max} from Okinawa as the primary value because the StepwiseLH value is likely an underestimate and thus unusable.

Table 44. Longevity data for *P. sieboldii*. Primary values are bolded.

Location	t_{max}	N	Usable	Source
Okinawa	**38**	**374**	**Primary**	**57**
StepwiseLH	18	---	No	34

Overall: No local life history information is available for *P. sieboldii*, and StepwiseLH provides most of the primary values.

Table 45. Primary life history parameter values for *P. sieboldii*. Standard errors marked with '*' are provided in log-space, as the corresponding parameter is lognormally distributed.

Parameter	Value	SE	Local	Source	Notes
L_∞	35.2	2.2	No	34	StepwiseLH estimate
k	0.33	0.42*	No	34	StepwiseLH estimate
t_0	-0.6	---	No	34	StepwiseLH estimate
a	0.0257	2.04e-3	Yes	---	From biosampling data
b	2.89	0.0230	Yes	---	From biosampling data
L_{50}	23.7	3.8	No	34	StepwiseLH estimate
t_{max}	38	2.8	No	57	Variance estimated from sample size (Nadon 2017)

Pristipomoides zonatus

Four growth curves are available for *P. zonatus*, one of which is from a high quality study using local data and is identified as the primary source. The only other usable source is StepwiseLH, which is unlikely to offer any improvement over the local growth curve.

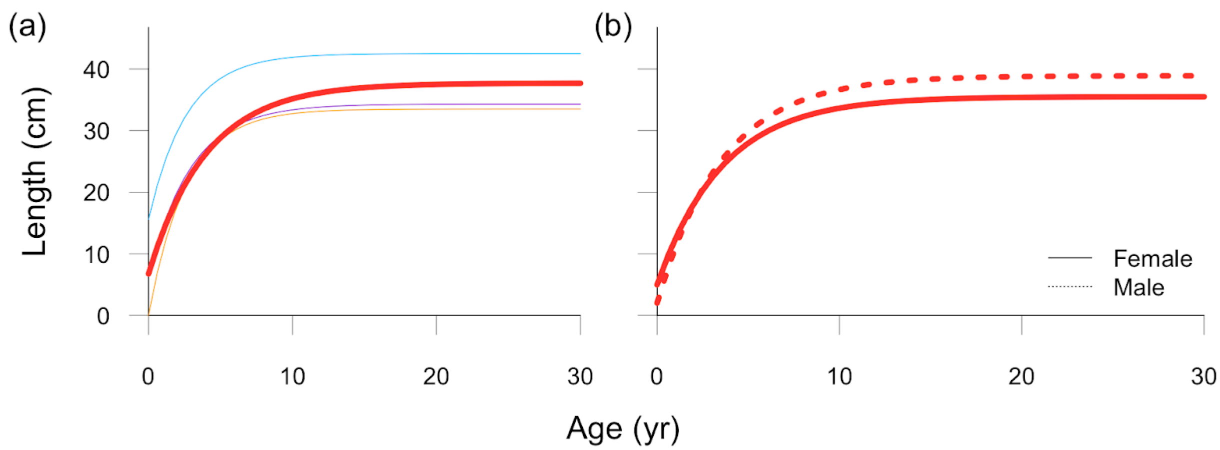

Figure 12. Von Bertalanffy growth curves for *P. zonatus* (a) by region and (b) by sex within each region, where available. The primary growth curves are bolded. See Table 46 for additional legend.

Table 46. Von Bertalanffy growth parameters for *P. zonatus*. Primary values are bolded.

Location	Group	L_∞	k	t_0	N	Usable	Source
All of Hawaii	All	42.5	0.38	-1.2	39	No	4
Guam	**All**	**37.7**	**0.25**	**-0.79**	**308**	**Primary**	**50**
	Female	**35.5**	**0.28**	**-0.54**	**119**	**Primary**	**50**
	Male	**38.9**	**0.28**	**-0.19**	**84**	**Primary**	**50**
StepwiseLH	All	34.3	0.34	-0.6	---	Yes	34
Papua New Guinea	All	33.5	0.38	0	24	No	18

Two maturity sources are available for *P. zonatus*, and we identify the local life history study from Guam as the primary source. StepwiseLH is unlikely to offer any improvement over the local values.

Table 47. Maturity data for *P. zonatus*. Primary values are bolded.

Location	Sex	L_{50}	L_∞	L_{50} / L_∞	*N*	Usable	Source
Guam	**Female**	**23.6**	**35.5**	**0.66**	**119**	**Primary**	**50**
	Male	**24.2**	**38.9**	**0.62**	**84**	**Primary**	**50**
StepwiseLH	All	22.7	34.3	0.66	---	Yes	34

The local t_{max} for *P. zonatus* is 38 yr, which is lower than the estimate of over 50 years for Western Australia. Given that the local value is from an unfished area of the Marianas Archipelago and without good data to justify the significantly higher t_{max} from Western Australia, we identify the local estimate as the primary value.

Table 48. Longevity data for *P. zonatus*. Primary values are bolded.

Location	t_{max}	*N*	Usable	Source
Western Australia	50+	unsp.	Yes	60
Marianas (unfished)	**38**	**unsp.**	**Primary**	**51**
Guam	30	308	Yes	50
All of Hawaii	26	39	Yes	4
StepwiseLH	18	---	No	34
Papua New Guinea	13	24	No	18

Outcome: Recent life history studies of *P. zonatus* from Guam and the other Mariana Islands provide reliable life history parameter estimates.

Table 49. Primary life history parameter values for *P. zonatus*.

Parameter		Value	SE	Local	Source	Notes
L_∞ -	All	37.7	0.52	Yes	50	
	Female	35.5	0.66	Yes	50	
	Male	38.9	0.71	Yes	50	
k -	All	0.25	0.015	Yes	50	
	Female	0.28	0.023	Yes	50	
	Male	0.28	0.020	Yes	50	
t_0 -	All	-0.79	0.18	Yes	50	
	Female	-0.54	0.20	Yes	50	

	Male	-0.19	0.18	Yes	50	
a		0.0160	4.59e-4	Yes	---	From biosampling data
b		3.08	0.0102	Yes	---	From biosampling data
L_{50} -	Female	23.6	0.33	Yes	50	
	Male	24.2	0.77	Yes	50	
t_{max}		38	2.2	Yes	51	Variance estimated from sample size (Nadon 2017)

Variola louti

Five growth curves are available for *V. louti* and exhibit high regional variation in L_∞. One of these sources is a high quality study using local data, and is identified as the primary source. Still, it is perplexing that diver surveys in the northern Mariana Archipelago (Ayotte et al. 2015) observed an 80 cm individual, given the local L_∞ estimate of 43.7 cm. L_{99} from the diver survey data is notably lower at 55 cm, so the 80 cm may be a data entry error. We identify three alternate growth curves that may be appropriate if outstanding fish are found to vastly exceed the primary source L_∞.

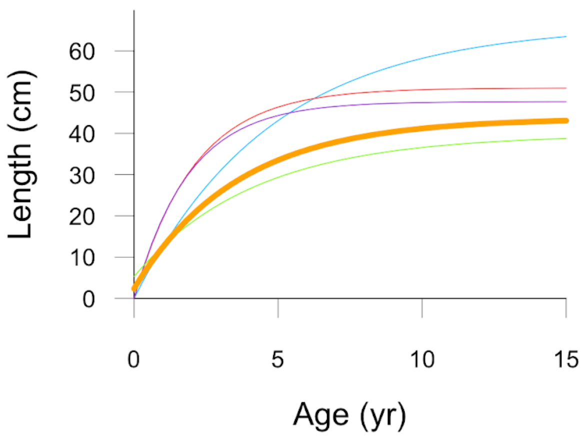

Figure 13. Von Bertalanffy growth curves for *V. louti* by region. The primary growth curve is bolded. See Table 50 for additional legend.

Table 50. Von Bertalanffy growth parameters for *V. louti*. Primary values are bolded.

Location	Group	L_∞	k	t_0	N	Usable	Source
Reunion	All	66.3	0.21	0	31	No	31
Seychelles	All	51.0	0.48	0	101	Alternate	19
Great Barrier Reef	All	47.7	0.53	0	58	Alternate	10
Guam	**All**	**43.7**	**0.28**	**-0.2**	**287**	**Primary**	**49**
StepwiseLH	All	39.7	0.24	-0.6	---	Alternate	17

V. louti is a monandric protogynous hermaphrodite (Schemmel & Dahl 2023). The primary local source provides estimates of both L_{50} and $L_{\Delta 50}$.

Table 51. Maturity data for *V. louti*. Primary values are bolded.

Location	Sex	L_{50}	$L_{\Delta 50}$	L_∞	L_{50} / L_∞	*N*	Usable	Source
Reunion	All	29.4	---	66.3	0.44	31	Yes	31
Great Barrier Reef	All	---	47.6	47.7	---	58	Yes	32
Guam	**All**	**26.0**	**35.5**	**43.7**	**0.59**	**255**	**Primary**	**49**
StepwiseLH	All	23.6	---	39.7	0.59	---	Yes	17

Local data provides a t_{max} estimate of 17 yr, which is slightly lower than the StepwiseLH estimate of 19 yr. It is possible that the true t_{max} is higher than the local estimate, as other studies demonstrate much higher longevity estimates from relatively unfished areas than fished areas within the Mariana Archipelago (O'Malley et al. 2019). Still, without good data to justify a specific higher t_{max}, we identify the local estimate as the primary value.

Table 52. Longevity data for *V. louti*. Primary values are bolded.

Location	t_{max}	*N*	Usable	Source
StepwiseLH	19	---	Yes	17
Guam	**17**	**287**	**Primary**	**49**
Seychelles	15	101	Yes	19
Great Barrier Reef	7	58	Yes	32
Reunion	6	31	No	31

Outcome: Excellent local life history data is available for *V. louti*.

Table 53. Primary life history parameter values for *V. louti*.

Parameter	Value	SE	Local	Source	Notes
L_∞	43.7	0.97	Yes	49	
k	0.28	0.020	Yes	49	
t_0	-0.2	0.13	Yes	49	
a	0.0140	8.93e-4	Yes	---	From biosampling data
b	3.07	0.0179	Yes	---	From biosampling data
L_{50}	26.0	0.43	Yes	49	
$L_{\Delta 50}$	35.5	0.33	Yes	49	

t_{max}	17	1.3	Yes	49	Variance estimated from sample size (Nadon 2017)

Acknowledgements

We greatly appreciate the painstaking work of Eva Schemmel, Kristen Dahl, Erin Reed, and all those who have contributed to life history science in Guam and the neighboring islands. They have gone above and beyond to expedite the processing and analysis of samples in order to provide the best information available for several BMUS. We also thank the survey staff, fishermen, and vendors who graciously provided many of the samples used for these studies. Their eager involvement and commitment to cooperation must be commended.

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