Life History of Bottomfish Management Unit Species of Guam

Toby Matthews and Erin C. Bohaboy

NOAA Technical Memorandum NMFS-PIFSC-170
Pacific Islands Fisheries Science Center
National Oceanic and Atmospheric Administration
U.S. Department of Commerce

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Pacific Islands Fisheries Science Center
National Marine Fisheries Service
1845 Wasp Boulevard
Honolulu, HI 96818

NOAA Technical Memorandum NMFS-PIFSC-170

November 2024

U.S. Department of Commerce
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Cover photo: *Etelis spp*. collected for life history research in the Northern Mariana Islands. Photo credit: Eva Schemmel, NOAA Fisheries.

Edited by Jill Coyle

Recommended citation

Matthews T., Bohaboy, E.B. (2024). Life history of Bottomfish Management Unit Species of Guam. NOAA Technical Memorandum. NMFS-PIFSC-170. doi:10.25923/wqxx-ed90

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Executive Summary

Results from scientific literature and unpublished data were aggregated to document growth, maturity, longevity, and other life history trait values for each Guam Bottomfish Management Unit Species (BMUS).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 that best represent local dynamics were identified. 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, either due to a complete lack of local data or the availability of greater estimates from elsewhere that were deemed usable. While excellent local values are available for some species, we identified values from several alternate sources that may be considered for many species and traits in future stock assessment of the Guam BMUS.

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 which was conducted in July 2024 as part of the Western Pacific Stock Assessment Review (WPSAR), to review data for use in the upcoming benchmark stock assessments of Guam BMUS. Previous stock assessments of the BMUS have been conducted on the aggregate multi-species complex, most recently in the 2019 benchmark stock assessment (Langseth et al., 2019), which was updated in 2024 (Bohaboy & 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 it can be derived using several empirical estimators based on other life history parameters such as growth, maturity, and longevity (Maunder et al., 2023). 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	g * 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:

$$L_t = L_\infty\left(1 - e^{-k(t-t_0)}\right)$$

We excluded published studies that were potentially unreliable. First, studies that exclusively aged fish using daily-growth increments, such as by

Ralston & Williams (1988), were excluded. This technique tends to underestimate the age of older fish (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 & 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 Guam 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-identification 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 data set for each BMUS as the input to StepwiseLH.

While StepwiseLH produces estimates of t_{max}, these values were deemed unreliable for BMUS of the genera *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 genera. As with the carangids, this caused 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 lengths exceed the local study estimates. 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}			L_{max} Filter	L_{99}
	Survey	Study	Source		
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. rubrioperculatus	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 fit of the von Bertalanffy growth function to the data 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. In some cases, these 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 for completeness, and because these sources may still provide reasonable approximate values for some applications.

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 et al. (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 were available for *A. rutilans* and exhibited high regional variation in L_∞ (Figure 1,Table 3). Although the local growth curve from the CNMI had limited sample size (N = 40), its L_∞ was very close to the value obtained through StepwiseLH, which was informed by a large quantity of biosampling lengths when deriving the L_{99} value. We identified the CNMI growth curve as the primary source because the parameter values appeared appropriate despite the limited sample size. We also identified three alternate growth curves due to potential imprecision in the CNMI growth curve arising from its limited sample size.

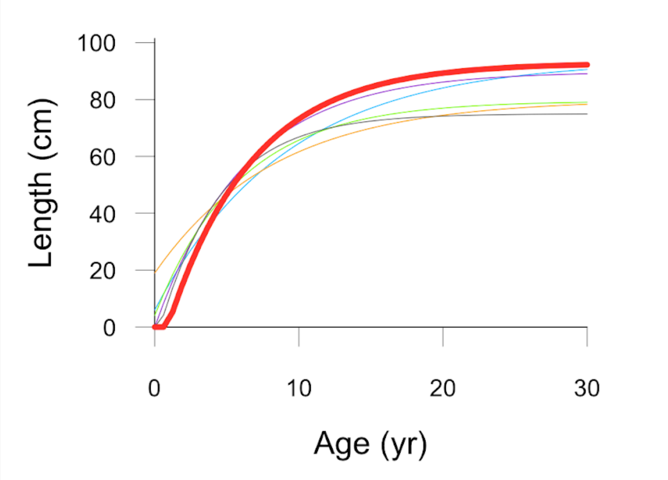

Figure 1. Von Bertalanffy growth curves for *A. rutilans* by region. The primary growth curve is bolded. The legend for colors by region is provided in Table 3.

Table 3. Von Bertalanffy growth parameters for *A. rutilans*.

Location	Group	L_∞	*k*	t_0	*N*	Category	Source
StepwiseLH	All	93.8	0.11	-0.6	---	Alternate	(Nadon & Ault, 2016)
CNMI	All	92.9	0.17	0.89	40	Primary	(Dahl & Schemmel, 2023)
Papua New Guinea	All	89.8	0.16	0	14	No	(Fry et al., 2006)
American Samoa	All	80.0	0.12	-2.26	102	No	(Dahl & Schemmel, 2023)
CNMI + AS + MHI	All	79.5	0.17	-0.31	242	Alternate	“
Main Hawaiian Islands	All	75.0	0.23	0.36	100	Alternate	“

StepwiseLH provided the only maturity parameter estimates for *A. rutilans* (Table 4). The L_{50} value was scaled to the L_∞ value from the primary CNMI growth curve to account for the slight difference in L_∞ between sources.

Table 4. Maturity parameters for *A. rutilans*.

Location	Sex	L_{50}	L_∞	L_{50} / L_∞	*N*	Category	Source
StepwiseLH	All	50.8	93.8	0.54	---	Primary	(Nadon & Ault, 2016)

Several longevity estimates were available for *A. rutilans* (Table 5). The local t_{max} value from the CNMI was 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 (MHI), we identified the maximal t_{max} value from the MHI as the primary value. We identified three alternate sources due to the lack of a well-informed local t_{max} estimate.

Table 5. Longevity estimates for *A. rutilans* by region.

Location	t_{max}	*N*	Category	Source
Main Hawaiian Islands	34	100	Primary	11(Dahl & Schemmel, 2023)
StepwiseLH	32	---	Alternate	34 (Nadon & Ault, 2016)
CNMI	25	40	Alternate	(Dahl & Schemmel, 2023)
American Samoa	18	102	Alternate	“
Papua New Guinea	16	14	No	(Fry et al., 2006)

Outcome: Life history information for *A. rutilans* (Table 6) was of moderate but usable quality. Notably and at the time of writing this report in mid-2024, the Pacific Islands Fisheries Science Center Life History Program was working to analyze more local life history samples and generate local life history information.

Table 6. Primary life history parameters for *A. rutilans*.

Parameter	Value	SE	Local	Source	Notes
L_∞	92.9	10.3	Yes	(Dahl & Schemmel, 2023)	
k	0.17	0.051	Yes	"	
t_0	0.89	---	Yes	"	
a	0.0255	8.42e-4	Yes	---	From biosampling data
b	2.84	7.65e-3	Yes	---	"
L_{50}	50.3	9.4	No	(Nadon & Ault, 2016)	StepwiseLH estimate, scaled to selected L_∞
t_{max}	34	3.1	No	(Dahl & Schemmel, 2023)	Variance estimated from sample size (Nadon, 2017)

Caranx ignobilis

Four growth curves were available for *C. ignobilis* and exhibited high regional variation in L_∞ (Figure 2, Table 7). This variation may reflect indeterminate growth of the species and difficulties in obtaining large *C. ignobilis* specimens in fished regions. For example, Andrews (2020) recorded a 149.7 cm female caught in the MHI even though the growth curve from the same regions indicates a L_∞ of 107.7 cm (Pardee et al., 2021). 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 identified the MHI growth curve as the primary source given the similar L_{max} values between it and the Mariana Archipelago. We also identified two alternate growth curves that may be appropriate given evidence that outstanding fish can vastly exceed the primary source L_∞.

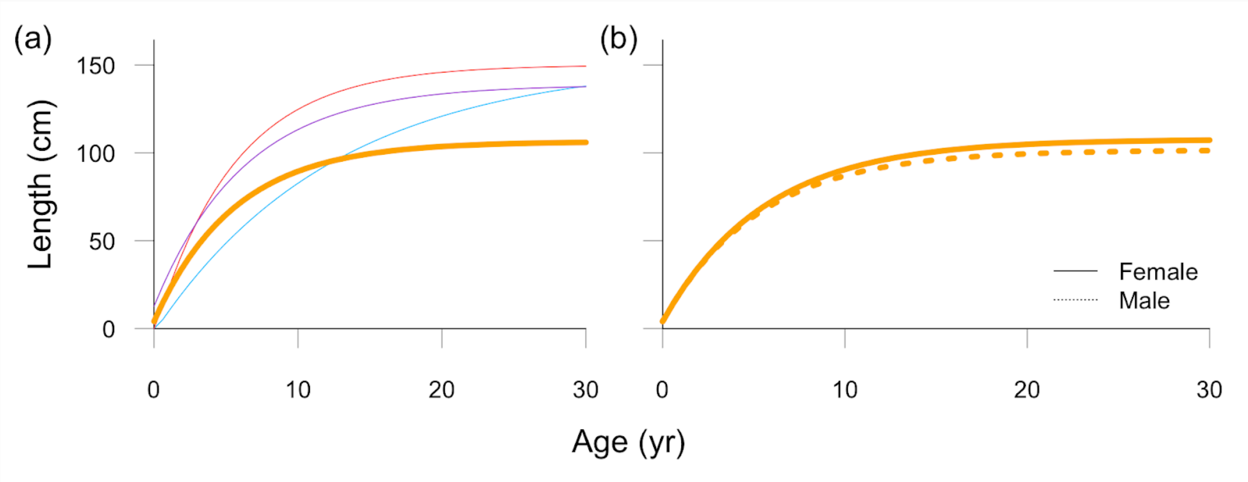

Figure 2. Von Bertalanffy growth curves for *C. ignobilis* (a) by region and (b) by sex within each region where available. The primary growth curves are bolded. The legend for colors by region is provided in Table 7.

Table 7. Von Bertalanffy growth parameters for *C. ignobilis*.

Location	Group	L_∞	*k*	t_0	*N*	Usable	Source
Gulf of Aden	All	152.0	0.08	0.18	low	No	(Edwards & Shaher, 1991)
All of Hawai‘i	All	150	0.18	0.10	17	Alternate	(Andrews, 2020)
StepwiseLH	All	138.7	0.16	-0.6	---	Alternate	(Nadon & Ault, 2016)
Main Hawaiian Islands	All	106.4	0.18	-0.22	180	Primary	(Pardee et al., 2021)
	Female	107.7	0.18	-0.21	86	Primary	“

Location	Group	L_∞	*k*	t_0	*N*	Usable	Source
	Male	101.6	0.19	-0.22	57	Primary	"

Maturity parameter estimates were available to complement the primary growth curve from the MHI and were considered as the primary source (Table 8). We identified two alternate sources due to the lack of local maturity information.

Table 8. Maturity parameters for *C. ignobilis*.

Location	Sex	L_{50}	L_∞	L_{50} / L_∞	*N*	Usable	Source
NWHI	Female	64.3	150	0.43	124	Alternate	(Sudekum et al., 1991)
StepwiseLH	All	69.3	138.7	0.50	---	Alternate	(Nadon & Ault, 2016)
Main Hawaiian Islands	All	53.2	106.4	0.50	180	Primary	(Pardee et al., 2021)
	Female	59.4	107.7	0.55	86	Primary	"
	Male	46.5	101.6	0.46	57	Primary	"

The greatest t_{max} and primary value was from the MHI, complementing the primary growth and maturity sources (Table 9).

Table 9. Longevity estimates for *C. ignobilis*.

Location	t_{max}	*N*	Usable	Source
Main Hawaiian Islands	31	180	Primary	(Pardee et al., 2021)
Main Hawaiian Islands	25	7	Alternate	(Andrews, 2020)
StepwiseLH	13	---	No	(Nadon & Ault, 2016)
Papua New Guinea	11	1	No	(Fry et al., 2006)
New Caledonia	9	Low	No	(Loubens, 1980)

Outcome: No local life history information was available for *C. ignobilis*, but it appears this species exhibits similar dynamics in the MHI, from which good sources of growth, maturity, and longevity were available (Table 10).

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

Parameter		Value	SE	Local	Source	Notes
L_∞	All	106.4	1.9	No	(Pardee et al., 2021)	

Parameter		Value	SE	Local	Source	Notes
	Female	107.7	2.6	No	“	
	Male	101.6	2.9	No	“	
k	All	0.18	0.010	No	“	
	Female	0.18	0.013	No	“	
	Male	0.19	0.015	No	“	
t_0	All	-0.22	---	No	“	
	Female	-0.21	---	No	“	
	Male	-0.22	---	No	“	
a		0.0248	5.61e-4	Yes	---	From biosampling data
b		2.96	7.65e-3	Yes	---	“
L_{50}	All	53.2	1.7	No	41 (Pardee et al., 2021)	
	Female	59.4	1.2	No	“	
	Male	46.5	2.9	No	“	
t_{max}		31	3.5	No	“	Variance estimated from sample size (Nadon, 2017)

Caranx lugubris

Very little growth information was available for *C. lugubris*, and we identified Stepwise LH as the only usable source (Figure 3, Table 11).

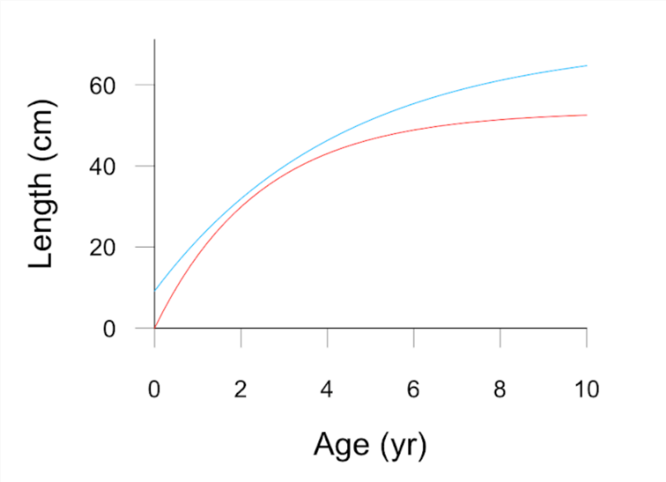

Figure 3. Von Bertalanffy growth curves for *C. lugubris* by region. The legend for colors by region is provided in Table 11.

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	(Nadon & Ault, 2016)
Papua New Guinea	All	53.4	0.41	0	12	No	(Fry et al., 2006)

StepwiseLH provided the only maturity parameter estimates for *C. lugubris* and was considered usable to complement the primary growth curve (Table 12).

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

Location	Sex	L_{50}	L_∞	L_{50} / L_∞	*N*	Usable	Source
StepwiseLH	All	39.0	70.9	0.55	---	Yes	(Nadon & Ault, 2016)

No usable longevity parameter information was available for *C. lugubris* (Table 13). 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 estimates for *C. lugubris* by region.

Location	t_{max}	***N***	**Usable**	**Source**
Papua New Guinea	12	12	No	(Fry et al., 2006)
StepwiseLH	10	---	No	(Nadon & Ault, 2016)

Outcome: Very little life history information was available for *C. lugubris*. While StepwiseLH provided usable growth and maturity parameter estimates, it did not provide usable longevity estimates. Taken as a whole, there was not a full set of usable life history values for *C. lugubris*.

Etelis carbunculus

Although numerous life history studies were available for *E. carbunculus*, a cryptic species with much greater maximum length (*E. boweni*) was recently identified (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) were considered.

Six growth curves were available for *E. carbunculus*, none of which is local (Figure 4, Table 14). L_∞ is similar across the Pacific Ocean locations, although it appears *E. carbunculus* does not grow as large in the Indian Ocean. Notably, males reached smaller maximum length than females across most of the studies. Difficulties were encountered when estimating L_{99} for the StepwiseLH growth curve as different sources indicated noticeably different values. For this reason, the StepwiseLH growth curve should be used with caution. L_{max} in Guam has been reported to be about 60 cm (Dahl et al., 2024) which is similar to the value from the MHI and NWHI once outliers at 71.0 and 65.8 cm are removed (Nichols, 2019). We identified the growth curve for all of Hawaiʻi as the primary source given that differences between the MHI and NWHI values are minor and pooling information from all parts of the Hawaiian Archipelago improved the sample size available to estimate L_∞. We identified four alternate sources of growth parameter estimates due to the lack of local growth information.

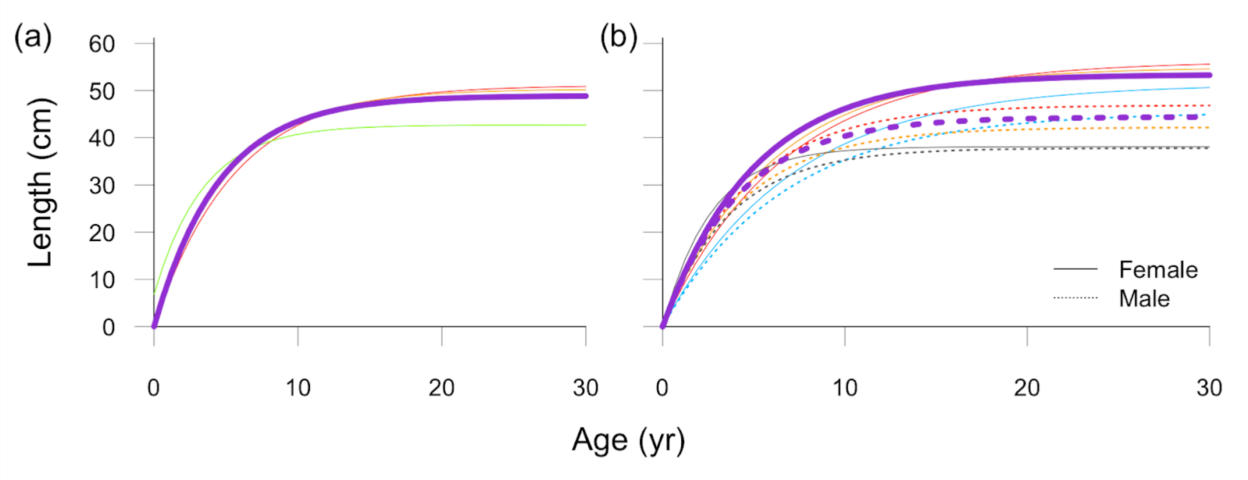

Figure 4. Von Bertalanffy growth curves for *E. carbunculus* (a) by region and (b) by sex within each region where available. The primary growth curves are bolded. The legend for colors by region is provided in Table 14.

Table 14. Von Bertalanffy growth parameters for *E. carbunculus*.

Location	Group	L_∞	*k*	t_0	*N*	Usable	Source
South Pacific	Female	51.4	0.14	0	195	Alternate	(Williams et al., 2017)
	Male	45.4	0.15	0	106	Alternate	"
NW Hawaiian Islands	All	51.1	0.18	0	138	Alternate	(Nichols, 2019)
	Female	56.2	0.15	0	81	Alternate	"
	Male	46.9	0.22	0	58	Alternate	"
All of Hawai‘i	All	48.9	0.22	0	621	Primary	(Nichols, 2019; Schemmel, 2024a)
	Female	53.4	0.20	0	348	Primary	"
	Male	44.4	0.24	0	254	Primary	"
Main Hawaiian Islands	All	50.3	0.20	0	343	Alternate	(Nichols, 2019)
	Female	54.9	0.17	0	186	Alternate	"
	Male	42.2	0.23	0	141	Alternate	"
StepwiseLH	All	42.7	0.29	-0.6	---	Alternate	(Nadon & Ault, 2016)
East Indian	Female	38.1	0.38	0	36	No	(Williams et al., 2017)
	Male	37.8	0.27	0	29	No	"

Maturity parameter estimates were available from the MHI and NWHI to complement the primary growth curve from all of Hawai‘i (Table 15). We recommend using values for the relatively unfished NWHI because we did not want to introduce assumptions regarding fishing-induced changes to *E. carbunculus* reproductive biology that would accompany using parameter values from the more heavily fished areas of the MHI. We identified two alternate sources due to the lack of local maturity information.

Table 15. Maturity parameters for *E. carbunculus*.

Location	Sex	L_{50}	L_∞	L_{50} / L_∞	*N*	Usable	Source
NW Hawaiian Islands	Female	27.2	56.2	0.48	194	Primary	(DeMartini, 2017; Nichols, 2019)
StepwiseLH	All	27.1	42.7	0.63	---	Alternate	(Nadon & Ault, 2016)
Main Hawaiian Islands	Female	23.4	54.9	0.43	215	Alternate	(DeMartini, 2017; Nichols, 2019)

Usable longevity estimates for *E. carbunculus* ranged from 22 to 33 yr, with the highest value from the NWHI (Table 16). Note the MHI provided a lower estimate of 22 yr which likely reflects the impact of fishing mortality rather than a real difference in longevity. Given the information from Hawaiʻi for growth and maturity, we identified this maximum value of 33 as the primary value. We identified three alternate sources due to the lack of local longevity information.

Table 16. Longevity estimates for *E. carbunculus*.

Location	t_{max}	*N*	Usable	Source
NW Hawaiian Islands	33	192	Primary	(Nichols, 2019)
East Indian	33	65	Alternate	(Williams et al., 2017)
South Pacific	32	301	Alternate	“
Main Hawaiian Islands	22	495	Alternate	(Nichols, 2019)
StepwiseLH	20	---	No	(Nadon & Ault, 2016)

Outcome: No local life history information was available for *E. carbunculus*, but it appears the species exhibits similar dynamics in Hawaiʻi, from which good sources of growth, maturity, and longevity were available (Table 17).

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

Parameter		Value	SE	Local	Source	Notes
L_∞	All	48.9	0.48	No	(Nichols, 2019; Schemmel, 2024a)	
	Female	53.4	0.65	No	"	
	Male	44.4	0.58	No	"	
k	All	0.22	5.78e-3	No	"	
	Female	0.20	5.95e-3	No	"	
	Male	0.24	9.21e-3	No	"	
t_0	All	0	---	No	"	
	Female	0	---	No	"	
	Male	0	---	No	"	
a		0.0162	4.85e-4	Yes	---	From biosampling data
b		3.02	7.65e-3	Yes	---	"
L_{50}	Female	27.2	1.12	No	(DeMartini, 2017)	
t_{max}		33	1.8	No	(Nichols, 2019)	Variance estimated from sample size (Nadon, 2017)

Etelis coruscans

Five growth curves were available for *E. coruscans*, none of which were local (Figure 5, Table 18). The maximum length recorded in the Guam biosampling data was 95.0 cm, which was similar to the MHI value of 97.0 cm (Reed et al., 2023). For this reason, we identified the MHI growth curve as the primary source. We identified three alternate sources due to the lack of local growth information.

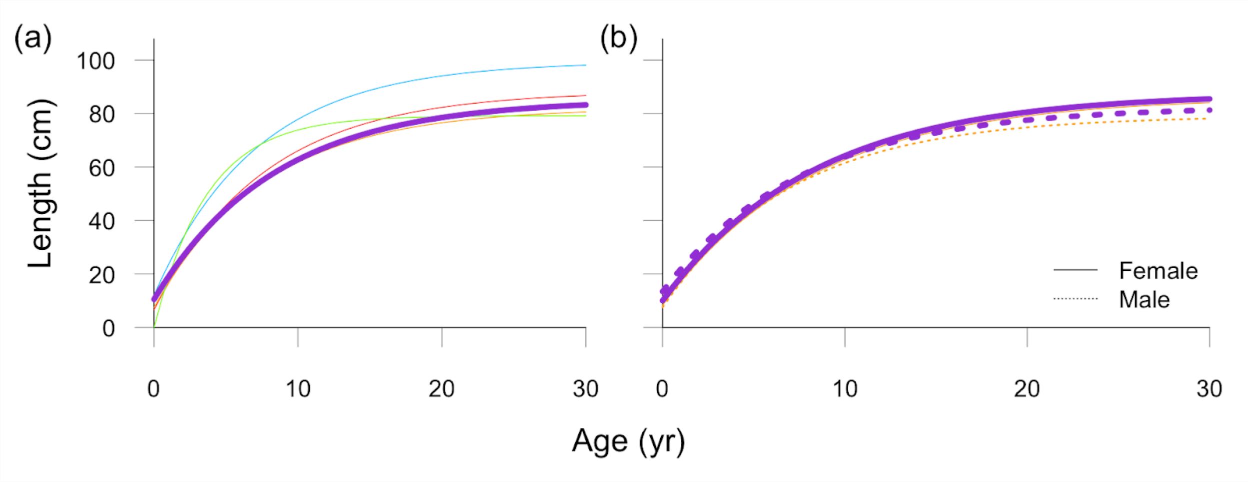

Figure 5. Von Bertalanffy growth curves for *E. coruscans* (a) by region and (b) by sex within each region where available. The primary growth curves are bolded. The legend for colors by region is provided in Table 18.

Table 18. Von Bertalanffy growth parameters for *E. coruscans*.

Location	Group	L_∞	*k*	t_0	*N*	Usable	Source
New Caledonia	All	99.4	0.14	-0.93	79	Alternate	(Williams et al., 2013)
StepwiseLH	All	88.4	0.13	-0.6	---	Alternate	(Nadon & Ault, 2016)
Main Hawaiian Islands	All	85.3	0.12	-1.10	187	Primary	(Andrews et al., 2021)
	Female	87.6	0.12	-1.02	114	Primary	“
	Male	82.7	0.13	-1.37	102	Primary	“
Okinawa	All	82.1	0.13	-0.74	749	Alternate	(Uehara et al., 2020)
	Female	86.2	0.12	-0.85	417	Alternate	“
	Male	79.2	0.14	-0.72	351	Alternate	“
Papua New Guinea	All	79.2	0.27	0	6	No	(Fry et al., 2006)

Local maturity parameter estimates were available for *E. coruscans* and were considered as the primary source (Table 19).

Table 19. Maturity parameters for *E. coruscans*.

Location	Sex	L_{50}	L_∞	L_{50} / L_∞	*N*	Usable	Source
Okinawa	Female	67.1	86.2	0.78	324	Yes	(Uehara et al., 2018)
	Male	37.6	79.2	0.47	292	Yes	“
Main Hawaiian Islands	Female	65.8	87.6	0.75	149	Yes	(Andrews et al., 2021; Reed et al., 2023)
Guam	Female	58.4	---	---	202	Primary	(Reed, 2023)
StepwiseLH	All	48.5	88.4	0.55	---	Yes	(Nadon & Ault, 2016)

Usable longevity estimates for *E. coruscans* ranged from 18 to 55 yr, although none were local (Table 20). The estimate from the primary growth source of the MHI was 55 yr. Given that the value from Okinawa was also 55 yr, we identified the maximum value of 55 yr as the primary value. We identified three alternate sources due to the lack of local longevity information.

Table 20. Longevity estimates for *E. coruscans*.

Location	t_{max}	*N*	Usable	Source
Main Hawaiian Islands	55	188	Primary	(Andrews et al., 2021)
Okinawa	55	749	Alternate	(Uehara et al., 2020)
South Pacific	40	165	Alternate	(Williams et al., 2015)
StepwiseLH	30	---	No	(Nadon & Ault, 2016)
Papua New Guinea	20	6	No	(Fry et al., 2006)
New Caledonia	18	79	Alternate	(Williams et al., 2013)

Outcome: Although no local life history information was available for *E. coruscans* except for maturity data, it appears the species exhibits similar dynamics in the MHI, from which good sources of growth and longevity information were available (Table 21).

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

Parameter		Value	SE	Local	Source	Notes
L_∞	All	85.3	1.0	No	(Andrews et al., 2021)	
	Female	87.6	1.2	No	“	
	Male	82.7	1.4	No	“	
k	All	0.12	0.006	No	“	
	Female	0.12	0.007	No	“	
	Male	0.13	0.008	No	“	
t_0	All	-1.10	0.19	No	“	
	Female	-1.02	0.21	No	“	
	Male	-1.37	0.26	No	“	
a		0.0387	2.40e-3	Yes	---	From biosampling data
b		2.77	0.0153	Yes	---	“
L_{50}	Female	58.4	1.1	Yes	(Reed, 2023)	
t_{max}		55	3.1	No	(Andrews et al., 2021)	Variance estimated from sample size (Nadon, 2017)

Lethrinus rubrioperculatus

Five growth curves were available for *L. rubrioperculatus* and exhibited high regional variation in L_∞ (Figure 6, Table 22). Although local growth curves were available, they were not usable, and the *k* values were 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 provided a similar L_∞ estimate. For this reason and given the substantial biosampling data used to inform the StepwiseLH values, we identified StepwiseLH as the primary source. We identified two alternate sources due to the lack of usable local growth information.

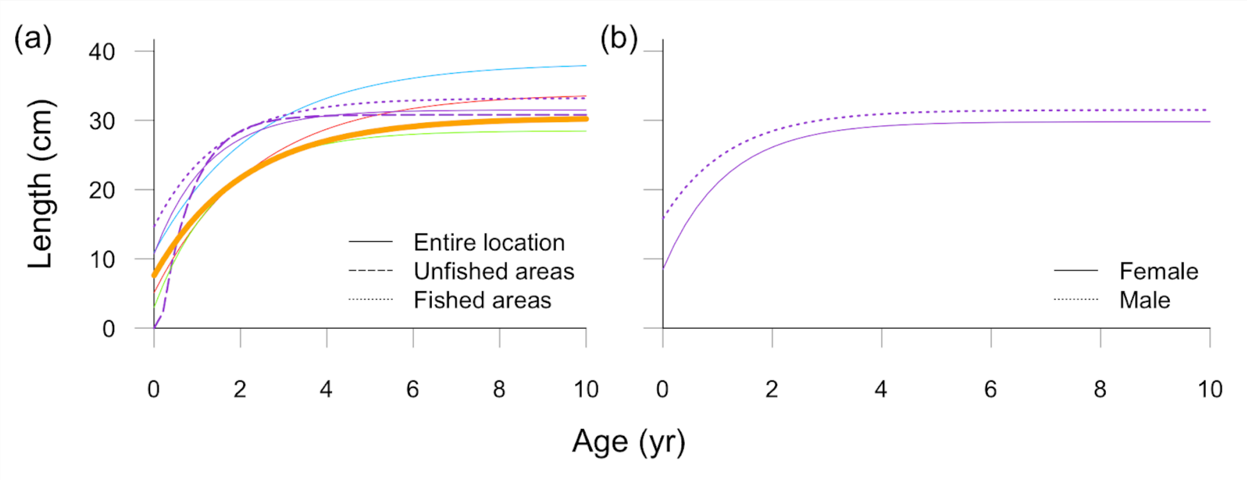

Figure 6. Von Bertalanffy growth curves for *L. rubrioperculatus* (a) by region and, where available, unfished and fished areas within each region and (b) by sex within each region where available. The primary growth curve is bolded. The legend for colors by region is provided in Table 22.

Table 22. Von Bertalanffy growth parameters for *L. rubrioperculatus*.

Location	Group	L_∞	*k*	t_0	*N*	Usable	Source
Okinawa	All	38.3	0.42	-0.8	635	No	(Ebisawa & Ozawa, 2009)
New Caledonia	All	33.9	0.43	-0.38	499	Alternate	(Loubens, 1980)
CNMI	All	31.5	0.8	-0.52	286	No	(Trianni, 2011)
	Female	29.8	0.88	-0.38	193	No	“
	Male	31.5	0.82	-0.85	89	No	“
	Unfished	30.8	1.39	0.15	161	No	“
	Fished	33.2	0.67	-0.87	125	No	(Trianni, 2011)

Location		Group	L_∞	*k*	t_0	*N*	Usable	Source
	StepwiseLH	All	30.4	0.48	-0.6	---	Primary	(Nadon & Ault, 2016)
	American Samoa	All	28.5	0.65	-0.17	114	Alternate	(Pardee et al., 2020)

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 were identified as the primary values (Table 23). We recommend using values for the relatively 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 more heavily fished areas of CNMI. However, we noted that L_{50} and $L_{\Delta 50}$ values, both in isolation and as a fraction of L_∞, were quite similar between fished and unfished areas.

Table 23. Maturity parameters for *L. rubrioperculatus*.

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	(Loubens, 1980)
StepwiseLH	All	23.5	---	30.4	0.77	---	Yes	(Nadon & Ault, 2016)
CNMI (fished)	All	23.2	29.0	33.2	0.70	421	Yes	(Trianni, 2011)
Okinawa	All	~22	~34	38.3	0.57	386	Yes	(Ebisawa, 1997; Ebisawa & Ozawa, 2009)
CNMI (unfished)	All	21.9	29.2	30.8	0.71	505	Primary	(Trianni, 2011)
American Samoa	All	20.4	---	28.5	0.72	---	No	(Pardee et al., 2020)

The local estimate of t_{max} (8 yr) was the lowest among sources (Table 24). Given similarly higher estimates from Okinawa, New Caledonia, and StepwiseLH, we identified the maximum value of 15 yr from New Caledonia as the primary value. We also identified five alternate sources due to differences between the primary and local estimates.

Table 24. Longevity estimates for *L. rubrioperculatus*.

Location	t_{max}	*N*	Usable	Source
New Caledonia	15	499	Primary	(Loubens, 1980)
StepwiseLH	14	---	Alternate	(Nadon & Ault, 2016)
Okinawa	13	635	Alternate	(Ebisawa & Ozawa, 2009)
Great Barrier Reef	11	unsp.	Alternate	Lou, D. C. Personal communication, in (Trianni, 2011)
American Samoa	10	114	Alternate	(Pardee et al., 2020)
CNMI	8	286	Alternate	(Trianni, 2011)

Outcome: Life history information for *L. rubrioperculatus* was of moderate but usable quality (Table 25).

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	(Nadon & Ault, 2016)	StepwiseLH estimate
k	0.48	0.45*	No	"	"
t_0	-0.6	---	No	"	"
a	0.0246	6.38e-4	Yes	---	From biosampling data
b	2.92	7.65e-3	Yes	---	"
L_{50}	20.1	0.40	Yes	(Trianni, 2011)	Scaled to selected L_∞
$L_{\Delta 50}$	26.7	0.19	Yes	"	"
t_{max}	15	0.84	No	(Loubens, 1980)	Variance estimated from sample size (Nadon, 2017)

Lutjanus kasmira

Five growth curves were available for *L. kasmira* and exhibited high regional variation in L_∞ (Figure 7, Table 26). No local growth curve was available, and it appears this species attains much larger size in the MHI 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 identified StepwiseLH as the primary source.

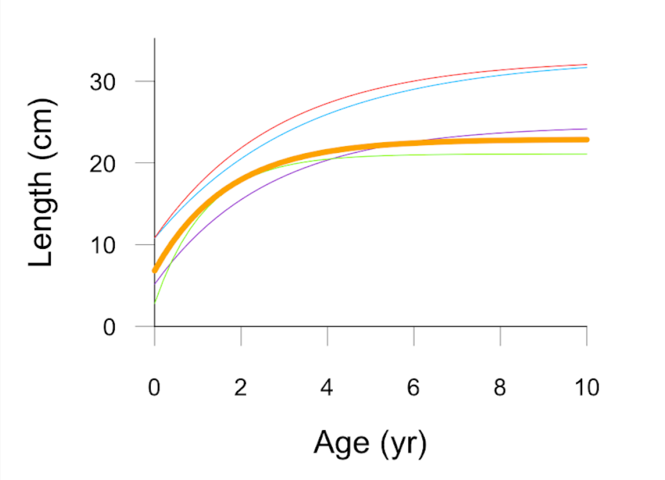

Figure 7. Von Bertalanffy growth curves for *L. kasmira* by region. The primary growth curve is bolded. The legend for colors by region is provided in Table 26.

Table 26. Von Bertalanffy growth parameters for *L. kasmira*.

Location	Group	L_∞	*k*	t_0	*N*	Usable	Source
Main Hawaiian Islands	All	32.9	0.29	-1.37	171	No	(Morales-Nin & Ralston, 1990)
Red Sea	All	32.7	0.35	-1.15	714	No	(Baker & Mehanna, 2024)
New Caledonia	All	24.6	0.38	-0.62	21	No	(Loubens, 1980)
StepwiseLH	All	22.9	0.59	-0.6	---	Primary	(Nadon & Ault, 2016)
American Samoa	All	21.1	0.84	-0.17	270	No	(Ochavillo, 2023)

No local maturity parameter estimates were available for *L. kasmira* (Table 27). Maturity information was available from three non-local sources, but given the substantial regional variation in L_∞ and use of StepwiseLH for primary growth values, we identified StepwiseLH as the primary source for maturity information. We identified two alternate sources due to the lack of local maturity information.

Table 27. Maturity parameters for *L. kasmira*.

Location	Sex	*L50*	L_∞	L_{50} / L_∞	*N*	Usable	Source
Red Sea	All	19.0	32.7	0.58	714	Alternate	(Baker & Mehanna, 2024)
Andaman Sea	All	19	---	---	792	Alternate	(Rangarajan, 1971)
StepwiseLH	All	17.5	22.9	0.77	---	Primary	(Nadon & Ault, 2016)

No local longevity data were available for *L. kasmira*, and four usable non-local sources provided a range of t_{max} values from 5 to 13 (Table 28). Both StepwiseLH and longevity data from American Samoa agreed on an estimated t_{max} of 13 yr, which we selected as the primary value. We identified three alternate sources due to the lack of local longevity information.

Table 28. Longevity estimates for *L. kasmira*.

Location	t_{max}	*N*	Usable	Source
American Samoa	13	270	Primary	(Ochavillo, 2023)
StepwiseLH	13	---	Alternate	(Nadon & Ault, 2016)
New Caledonia	8	21	No	(Loubens, 1980)
Main Hawaiian Islands	6	171	Alternate	(Morales-Nin & Ralston, 1990)
Papua New Guinea	6	2	No	(Fry et al., 2006)
Red Sea	5	714	Alternate	(Baker & Mehanna, 2024)

Outcome: No local life history information was available for *L. kasmira*, and StepwiseLH provided most of the primary values (Table 29).

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	(Nadon & Ault, 2016)	StepwiseLH estimate
k	0.59	0.44*	No	"	"
t_0	-0.6	---	No	"	"
a	0.0175	1.17e-3	Yes	---	From biosampling data
b	3.01	0.0230	Yes	---	"
L_{50}	17.5	2.7	No	(Nadon & Ault, 2016)	StepwiseLH estimate
t_{max}	13	0.96	No	(Ochavillo, 2023)	Variance estimated from sample size (Nadon, 2017)

Pristipomoides auricilla

Only two growth curves were available for *P. auricilla*, but one was from a high quality study using local data and was identified as the primary source (Figure 8, Table 30). We recommend using the growth curve from the relatively 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 more heavily fished populations. The only other source of growth information was from StepwiseLH, which is unlikely to offer any improvement over the local growth curve.

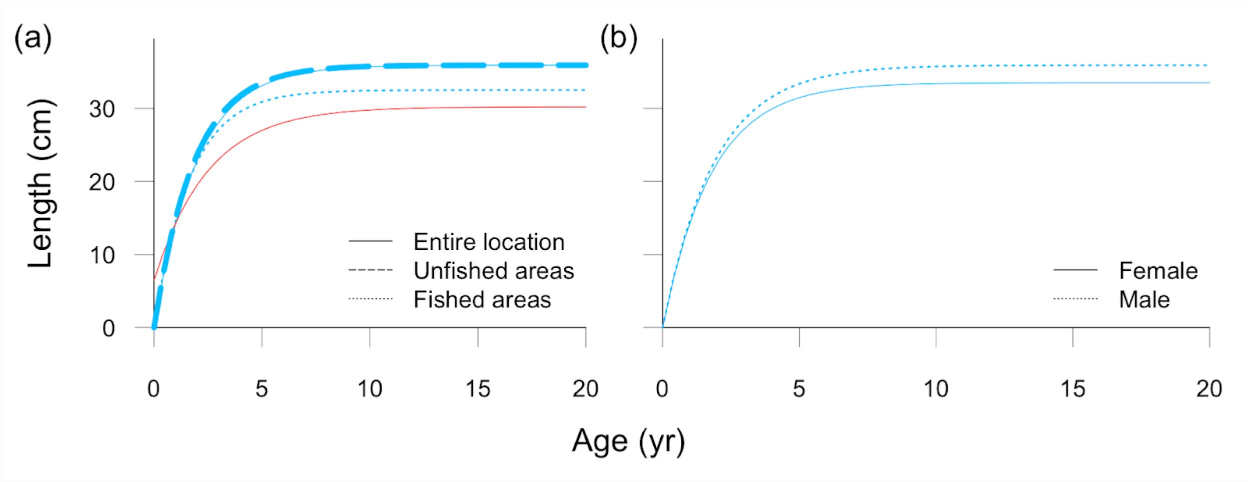

Figure 8. Von Bertalanffy growth curves for *P. auricilla* (a) by region and, where available, unfished and fished areas within each region and (b) by sex within each region where available. The primary growth curve is bolded. The legend for colors by region is provided in Table 30.

Table 30. Von Bertalanffy growth parameters for *P. auricilla*.

Location	Group	L_∞	k	t_0	N	Usable	Source
Mariana Archipelago	All	35.9	0.51	0	295	Yes	39 (O'Malley et al., 2019)
	Female	33.5	0.56	0	106	Alternate	"
	Male	35.9	0.53	0	160	Alternate	"
	Unfished	35.9	0.54	0	160	Primary	"
	Fished	32.5	0.6	0	135	Yes	"
StepwiseLH	All	30.2	0.40	-0.6	---	Yes	(Nadon & Ault, 2016)

There were only three sources of maturity parameter estimates for *P. auricilla*, two of which were local. We identified the Guam-specific source as primary.

Table 31. Maturity parameters for *P. auricilla*.

Location	**Sex**	***L_{50}***	***L_∞***	***L_{50} / L_∞***	***N***	**Usable**	**Source**
Guam	Female	24.5	33.5	0.73	104	Primary	(O'Malley et al., 2019; Schemmel, 2023a)
Mariana Archipelago	Female	23.7	33.5	0.71	229	Yes	"
StepwiseLH	All	21.1	30.2	0.70	---	Yes	(Nadon & Ault, 2016)

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

Table 32. Longevity estimates for *P. auricilla*.

Location	***t_{max}***	***N***	**Usable**	**Source**
Marianas (unfished)	32	160	Primary	39 (O'Malley et al., 2019)
Marianas (fished)	18	135	Yes	"
StepwiseLH	16	---	No	(Nadon & Ault, 2016)
Papua New Guinea	7	4	No	(Fry et al., 2006)

Outcome: Excellent local life history information were available for *P. auricilla* (Table 33).

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

Parameter	Value	SE	Local	Source	Notes
L_∞	35.9	0.26	Yes	39 (O'Malley et al., 2019)	
k	0.54	0.023	Yes	"	
t_0	0	---	Yes	"	
a	9.92e-3	1.84e-4	Yes	---	From biosampling data
b	3.20	5.10e-3	Yes	---	"
L_{50}	24.5	0.5	Yes	(Schemmel, 2023a)	
t_{max}	32	2.4	Yes	(O'Malley et al., 2019)	Variance estimated from sample size (Nadon, 2017)

Pristipomoides filamentosus

Seven growth curves were available for *P. filamentosus* and exhibited high regional variation in L_∞ (Figure 9, Table 34). Fortunately, a local growth curve was available and was selected as the primary source. Although separate local growth curves were available for unfished and fished areas, there was no substantial difference between them. For this reason, we selected the growth curve aggregated across the Mariana Archipelago as the primary growth curve.

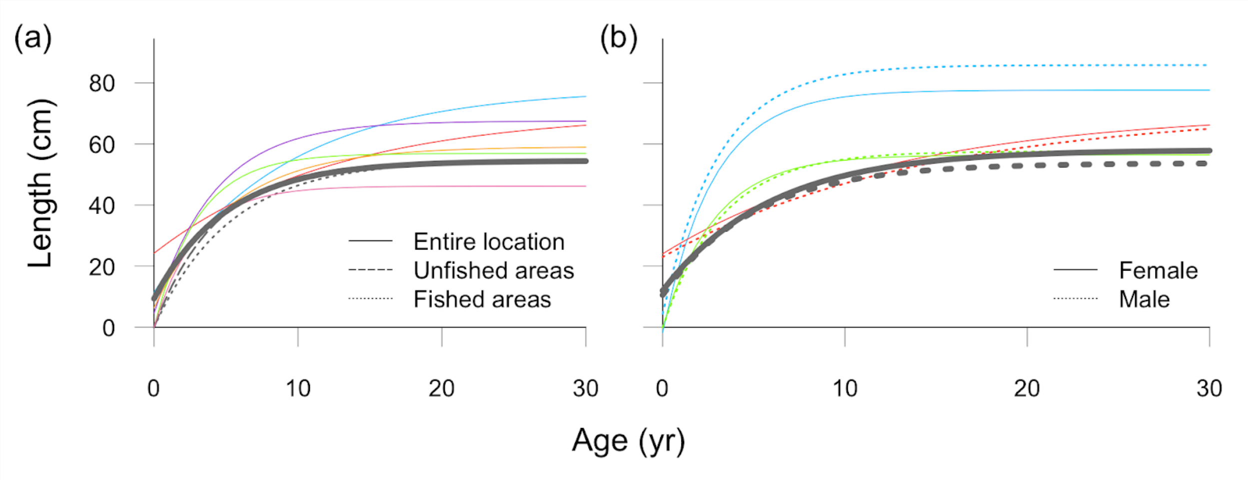

Figure 9. Von Bertalanffy growth curves for *P. filamentosus* (a) by region and, where available, unfished and fished areas within each region and (b) by sex within each region where available. The primary growth curves are bolded. The legend for colors by region is provided in Table 34.

Table 34. Von Bertalanffy growth parameters for *P. filamentosus*.

Location	Group	L_∞	*k*	t_0	*N*	Usable	Source
Seychelles	All	78.0	0.11	-1.44	85	No	(Andrews et al., 2012; Pilling et al., 2000)
	Female	77.6	0.36	0.06	unsp.	No	(Hardman-Mountford et al., 1997)
	Male	85.8	0.33	-0.16	unsp.	No	"
Okinawa	All	70.3	0.08	-5.28	303	No	(Uehara et al., 2020)
	Female	70.4	0.08	-5.22	162	No	"
	Male	70.8	0.07	-5.61	134	No	"
NW Hawaiian Islands	All	67.5	0.24	-0.29	36	Yes	(Andrews et al., 2012)
StepwiseLH	All	59.1	0.19	-0.6	---	Yes	(Nadon & Ault, 2016)

Location	Group	L_∞	k	t_0	N	Usable	Source
Main Hawaiian Islands	All	56.9	0.33	0	377	Yes	(Nichols, 2023)
	Female	56.4	0.35	0	202	Yes	“
	Male	57.6	0.31	0	175	Yes	“
Mariana Archipelago	All	54.5	0.20	-0.94	217	Yes	(Villagomez, 2019)
	Female	58.1	0.17	-1.36	83	Alternate	“
	Male	53.7	0.20	-1.09	127	Alternate	“
	Unfished	54.5	0.23	0	122	Primary	“
	Fished	54.6	0.19	0	95	Yes	“
Papua New Guinea	All	46.2	0.34	0	43	Yes	(Fry et al., 2006)

Five sources of maturity parameter estimates were available for *P. filamentosus*, again including a local source that was identified as the primary source (Table 35).

Table 35. Maturity parameters for *P. filamentosus*.

Location	Sex	L_{50}	L_∞	L_{50} / L_∞	N	Usable	Source
Main Hawaiian Islands	Female	40.7	56.4	0.72	479	Yes	(Luers et al., 2018; Nichols, 2023)
	Male	34.3	57.6	0.60	419	Yes	“
StepwiseLH	All	34.7	59.1	0.59	---	Yes	(Nadon & Ault, 2016)
Papua New Guinea	All	34.0	60.9	0.56	94	Yes	(Lokani et al., 1990)
Mariana Archipelago	All	32.6	54.5	0.60	254	Primary	(Villagomez, 2019)
	Female	41.2	58.1	0.71	111	Primary	“
	Male	27.6	53.7	0.51	143	Primary	“
Okinawa	Female	35.7	70.4	0.51	110	Yes	(Uehara et al., 2018, 2020)
	Male	≤ 20.0	70.8	≤ 0.28	88	No	“

Many longevity sources were available for *P. filamentosus*, with t_{max} values ranging from 30 to 64 yr from usable sources (Table 36). The local estimate was relatively low, at 31 yr. Given the broad similarities between Guam and the MHI identified for several BMUS, we selected the greater t_{max} estimate of 50 yr from the MHI as the primary value. We also identified five alternate sources due to differences between the primary and local estimates.

Table 36. Longevity estimates for *P. filamentosus*.

Location	t_{max}	*N*	Usable	Source
South Pacific	64	85	Alternate	(Williams et al., 2015)
Main Hawaiian Islands	50	399	Primary	(Nichols, 2023)
NW Hawaiian Islands	43	43	Alternate	(Andrews et al., 2012)
Okinawa	35	303	Alternate	(Uehara et al., 2020)
Mariana Archipelago	31	217	Alternate	(Villagomez, 2019)
Seychelles	30	242	Alternate	(Pilling et al., 2000)
StepwiseLH	24	---	No	(Nadon & Ault, 2016)
Papua New Guinea	12	43	No	(Fry et al., 2006)

Outcome: A large amount of life history information was available for *P. filamentosus*, including a local source that contributed most of the primary values (Table 37).

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

Parameter		Value	SE	Local	Source	Notes
L_∞	All	54.5	1.3	Yes	(Villagomez, 2019)	
	Female	58.1	2.9	Yes	"	
	Male	53.7	1.5	Yes	"	
k	All	0.20	0.030	Yes	"	
	Female	0.17	0.038	Yes	"	
	Male	0.20	0.037	Yes	"	
t_0	All	-0.94	0.56	Yes	"	
	Female	-1.36	0.94	Yes	"	
	Male	-1.09	0.69	Yes	"	
a		0.0252	1.15e-3	Yes	---	From biosampling data
b		2.90	0.0128	Yes	---	"

Parameter		Value	SE	Local	Source	Notes
L_{50}	All	32.6	0.68	Yes	(Villagomez, 2019)	Variance estimated from sample size (Nadon, 2017)
	Female	41.2	1.3	Yes	“	"
	Male	27.6	1.0	Yes	“	"
t_{max}		50	2.8	No	(Nichols, 2023)	Variance estimated from sample size (Nadon, 2017)

Pristipomoides flavipinnis

Three growth curves were available for *P. flavipinnis*, none of which was local (Figure 10, Table 38). L_{max} in Guam from a 1973 study by Kami (1973) was about 46 cm, which was 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 identified the Samoa Archipelago as the primary source. The growth curve for unfished areas was specifically chosen 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 identified an alternate source due to the lack of local growth information.

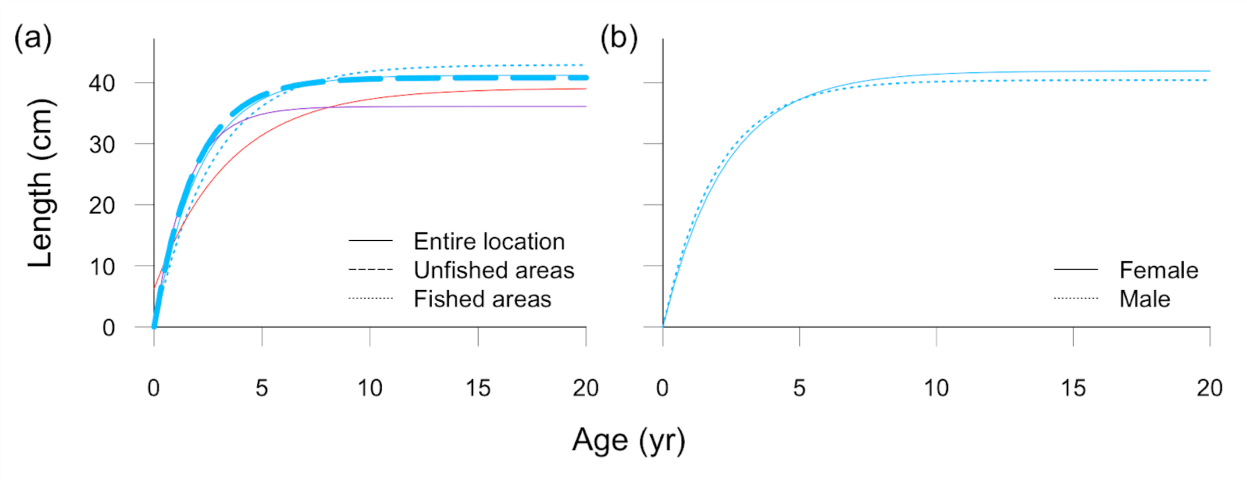

Figure 10. Von Bertalanffy growth curves for *P. flavipinnis* (a) by region and, where available, unfished and fished areas within each region and (b) by sex within each region where available. The primary growth curve is bolded. The legend for colors by region is provided in Table 38.

Table 38. Von Bertalanffy growth parameters for *P. flavipinnis*.

Location		Group	L_∞	*k*	t_0	*N*	Usable	Source
(blue)	Samoa Archipelago	All	41.2	0.47	0	373	Yes	(O'Malley et al., 2019)
		Female	41.9	0.44	0	179	Yes	"
		Male	40.4	0.51	0	194	Yes	"
		Unfished	40.8	0.53	0	312	Primary	"
		Fished	42.9	0.37	0	61	Yes	"
(red)	StepwiseLH	All	39.1	0.29	-0.6	---	Alternate	(Nadon & Ault, 2016)

Location	Group	L_∞	*k*	t_0	*N*	Usable	Source
Papua New Guinea	All	36.1	0.67	0	14	No	(Fry et al., 2006)

StepwiseLH provided the only maturity parameter estimates for *P. flavipinnis* (Table 39). 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 parameters for *P. flavipinnis*.

Location	Sex	L_{50}	L_∞	L_{50} / L_∞	*N*	Usable	Source
StepwiseLH	All	25.2	39.1	0.64	---	Primary	(Nadon & Ault, 2016)

Two usable sources of longevity estimates were available for *P. flavipinnis*, offering estimates of 10 and 28 yr from the unfished and fished areas of the Samoa Archipelago, respectively (Table 40). We identified the Samoa-wide maximum of 28 yr as the primary value.

Table 40. Longevity estimates for *P. flavipinnis*.

Location	t_{max}	*N*	Usable	Source
Samoas (unfished)	28	312	Primary	(O'Malley et al., 2019)
StepwiseLH	20	---	No	(Nadon & Ault, 2016)
Papua New Guinea	11	14	No	(Fry et al., 2006)
Samoas (fished)	10	61	Yes	(O'Malley et al., 2019)

Outcome: Although no local life history information was available for *P. flavipinnis*, it appears species biology is likely similar between Guam and Samoa Archipelago from which good sources of growth and longevity information were available (Table 41).

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

Parameter	Value	SE	Local	Source	Notes
L_∞	42.9	0.18	No	(O'Malley et al., 2019)	
k	0.37	0.020	No	"	
t_0	0	---	No	"	
a	0.0170	5.87e-4	Yes	---	From biosampling data
b	3.02	0.0102	Yes	---	"
L_{50}	27.6	6.3	No	(Nadon & Ault, 2016)	StepwiseLH estimate, scaled to selected L_∞
t_{max}	28	2.1	No	(O'Malley et al., 2019)	Variance estimated from sample size (Nadon, 2017)

Pristipomoides sieboldii

Only two growth curves were available for *P. sieboldii*, neither of which was local (Figure 11, Table 42). Furthermore, the Okinawa growth curve was not usable due to large negative t_0 values. The StepwiseLH growth curve was still considered usable as the primary source given the local length data used to inform it.

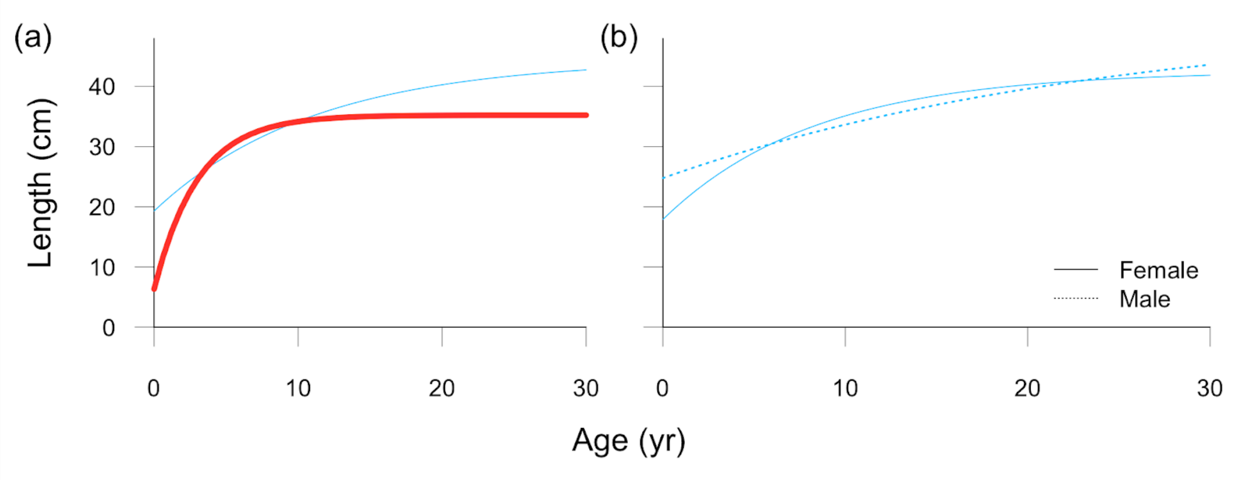

Figure 11. Von Bertalanffy growth curves for *P. sieboldii* (a) by region and (b) by sex within each region where available. The primary growth curve is bolded. The legend for colors by region is provided in Table 42.

Table 42. Von Bertalanffy growth parameters for *P. sieboldii*.

Location	Group	L_∞	*k*	t_0	*N*	Usable	Source
Okinawa	All	44.4	0.09	-6.33	374	No	(Uehara et al., 2020)
	Female	42.5	0.12	-4.55	275	No	"
	Male	51.7	0.04	-16.28	93	No	"
StepwiseLH	All	35.2	0.33	-0.6	---	Primary	(Nadon & Ault, 2016)

Four sources of maturity information were available for *P. sieboldii*, although none were local (Table 43). One was from the MHI which served as a good alternate source of data for several BMUS. In this case, StepwiseLH provided a similar L_{50} estimate to that from the MHI which lends confidence to the values. For this reason and given the choice of StepwiseLH as the primary growth data source, we identified StepwiseLH as the primary maturity information source. We identified three alternate sources due to the lack of local maturity information.

Table 43. Maturity parameters for *P. sieboldii*.

Location	Sex	L_{50}	L_{∞}	L_{50} / L_{∞}	*N*	Usable	Source
NW Hawaiian Islands	Female	28.6	---	---	83	Alternate	(DeMartini, 2017)
Okinawa	Female	24.6	42.5	0.58	226	Alternate	(Uehara et al., 2018, 2020)
	Male	≤ 24.0	51.7	≤ 0.46	94	No	"
Main Hawaiian Islands	Female	23.8	---	---	198	Alternate	(DeMartini, 2017)
StepwiseLH	All	23.7	35.2	0.67	---	Primary	(Nadon & Ault, 2016)

Longevity estimates were only available for *P. sieboldii* from Okinawa and StepwiseLH (Table 44), which provided widely different estimates (t_{max} = 38 and 18 years for Okinawa and StepwiseLH, respectively). We selected the greater t_{max} from Okinawa as the primary value because the StepwiseLH value is likely an underestimate and thus unusable.

Table 44. Longevity estimates for *P. sieboldii*.

Location	t_{max}	*N*	Usable	Source
Okinawa	38	374	Primary	(Uehara et al., 2020)
StepwiseLH	18	---	No	(Nadon & Ault, 2016)

Overall: No local life history information was available for *P. sieboldii*, and StepwiseLH provided most of the primary values (Table 45).

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	(Nadon & Ault, 2016)	StepwiseLH estimate
k	0.33	0.42*	No	"	"
t_0	-0.6	---	No	"	"
a	0.0257	2.04e-3	Yes	---	From biosampling data
b	2.89	0.0230	Yes	---	"
L_{50}	23.7	3.8	No	(Nadon & Ault, 2016)	StepwiseLH estimate
t_{max}	38	2.8	No	(Uehara et al., 2020)	Variance estimated from sample size (Nadon, 2017)

Pristipomoides zonatus

Four growth curves were available for *P. zonatus*, one of which was from a high quality study using local data and was identified as the primary source (Figure 12, Table 46). The only other usable source was StepwiseLH which was unlikely to offer any improvement over the local growth curve.

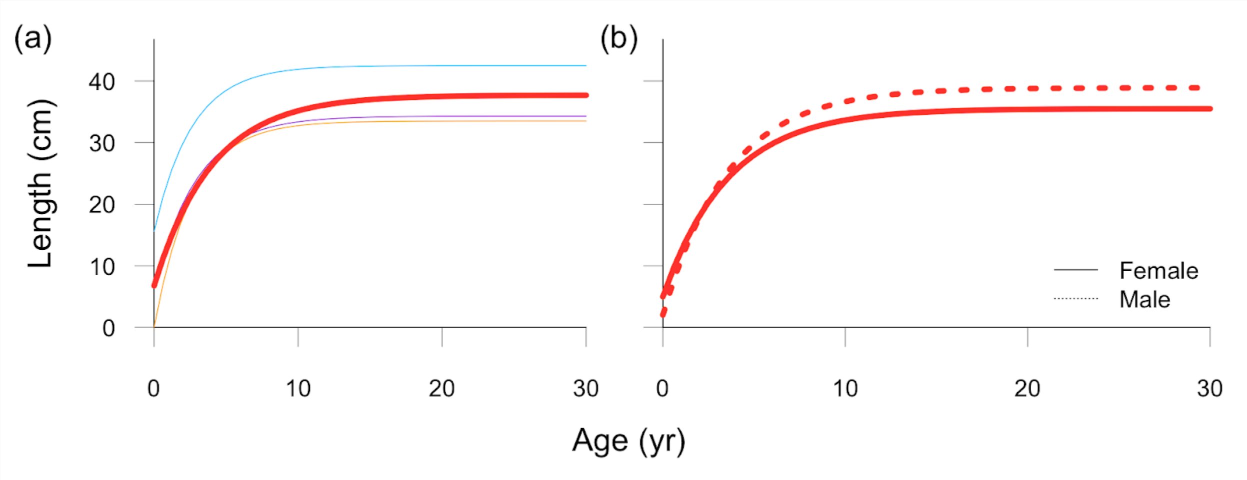

Figure 12. Von Bertalanffy growth curves for *P. zonatus* (a) by region and (b) by sex within each region where available. The primary growth curves are bolded. The legend for colors by region is provided in Table 46.

Table 46. Von Bertalanffy growth parameters for *P. zonatus*.

Location	Group	L_∞	*k*	t_0	*N*	Usable	Source
All of Hawai‘i	All	42.5	0.38	-1.2	39	No	(Andrews & Scofield, 2021)
Guam	All	37.7	0.25	-0.79	308	Primary	(Schemmel, 2023b)
	Female	35.5	0.28	-0.54	119	Primary	“
	Male	38.9	0.28	-0.19	84	Primary	“
StepwiseLH	All	34.3	0.34	-0.6	---	Yes	(Nadon & Ault, 2016)
Papua New Guinea	All	33.5	0.38	0	24	No	(Fry et al., 2006)

Two maturity information sources were available for *P. zonatus*, and we identified the local life history study from Guam as the primary source (Table 47). StepwiseLH is unlikely to offer any improvement over the local values.

Table 47. Maturity parameters for *P. zonatus*.

Location	Sex	L_{50}	L_∞	L_{50} / L_∞	*N*	Usable	Source
Guam	Female	23.6	35.5	0.66	119	Primary	(Schemmel, 2023b)
	Male	24.2	38.9	0.62	84	Primary	"
StepwiseLH	All	22.7	34.3	0.66	---	Yes	(Nadon & Ault, 2016)

The local t_{max} for *P. zonatus* was 38 yr which is lower than the estimate of over 50 years for Western Australia (Table 48). Given that the local value was from an unfished area of the Mariana Archipelago and without good data to justify the significantly higher t_{max} from Western Australia, we identified the local estimate as the primary value.

Table 48. Longevity estimates for *P. zonatus*.

Location	t_{max}	*N*	Usable	Source
Western Australia	50+	unsp.	Yes	Wakefield, C. B. Personal communication, in (Andrews & Scofield, 2021)
Marianas (unfished)	38	unsp.	Primary	(Schemmel, 2024b)
Guam	30	308	Yes	(Schemmel, 2023b)
All of Hawaii	26	39	Yes	(Andrews & Scofield, 2021)
StepwiseLH	18	---	No	(Nadon & Ault, 2016)
Papua New Guinea	13	24	No	(Fry et al., 2006)

Outcome: Recent life history studies of *P. zonatus* from Guam and the other Mariana Islands provided reliable life history parameter estimates (Table 49).

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

Parameter		Value	SE	Local	Source	Notes
L_∞	All	37.7	0.52	Yes	(Schemmel, 2023b)	
	Female	35.5	0.66	Yes	"	
	Male	38.9	0.71	Yes	"	
k	All	0.25	0.015	Yes	"	
	Female	0.28	0.023	Yes	"	
	Male	0.28	0.020	Yes	"	
t_0	All	-0.79	0.18	Yes	"	
	Female	-0.54	0.20	Yes	"	
	Male	-0.19	0.18	Yes	"	
a		0.0160	4.59e-4	Yes	---	From biosampling data
b		3.08	0.0102	Yes	---	"
L_{50}	Female	23.6	0.33	Yes	(Schemmel, 2023b)	
	Male	24.2	0.77	Yes	"	
t_{max}		38	2.2	Yes	(Schemmel, 2024b)	Variance estimated from sample size (Nadon, 2017)

Variola louti

Five growth curves were available for *V. louti* and exhibited high regional variation in L_∞ (Figure 13, Table 50). One of these sources was a high quality study using local data and was 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 was notably lower at 55 cm, so the 80 cm may have been a data entry error. We identified three alternate growth curves that may be appropriate if outstanding fish are found to vastly exceed the primary source L_∞.

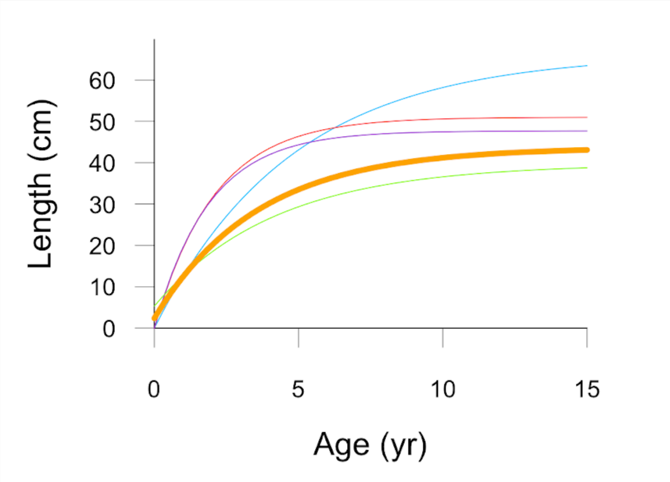

Figure 13. Von Bertalanffy growth curves for *V. louti* by region. The primary growth curve is bolded. The legend for colors by region is provided in Table 50.

Table 50. Von Bertalanffy growth parameters for *V. louti*.

Location	Group	L_∞	*k*	t_0	*N*	Usable	Source
Reunion	All	66.3	0.21	0	31	No	(Mahé et al., 2022)
Seychelles	All	51.0	0.48	0	101	Alternate	(Grandcourt, 2005)
Great Barrier Reef	All	47.7	0.53	0	58	Alternate	(Currey et al., 2010)
Guam	All	43.7	0.28	-0.2	287	Primary	(Schemmel & Dahl, 2023)
StepwiseLH	All	39.7	0.24	-0.6	---	Alternate	(Erickson & Nadon, 2021)

V. louti is a monandric protogynous hermaphrodite (Schemmel & Dahl, 2023). The primary local source provided estimates of both L_{50} and $L_{\Delta 50}$ (Table 51).

Table 51. Maturity parameters for *V. louti*.

Location	Sex	L_{50}	$L_{\Delta 50}$	L_∞	L_{50} / L_∞	*N*	Usable	Source
Reunion	All	29.4	---	66.3	0.44	31	Yes	(Mahé et al., 2022)
Great Barrier Reef	All	---	47.6	47.7	---	58	Yes	(Mapleston et al., 2009)
Guam	All	26.0	35.5	43.7	0.59	255	Primary	(Schemmel & Dahl, 2023)
StepwiseLH	All	23.6	---	39.7	0.59	---	Yes	(Erickson & Nadon, 2021)

Local information provided a t_{max} estimate of 17 yr, which was slightly lower than the StepwiseLH estimate of 19 yr (Table 52). It is possible that the true t_{max} is higher than the local estimate, because other studies have demonstrated higher longevity estimates of deepwater fishes 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 identified the local estimate as the primary value.

Table 52. Longevity estimates for *V. louti*.

Location	t_{max}	*N*	Usable	Source
StepwiseLH	19	---	Yes	(Erickson & Nadon, 2021)
Guam	17	287	Primary	(Schemmel & Dahl, 2023)
Seychelles	15	101	Yes	(Grandcourt, 2005)
Great Barrier Reef	7	58	Yes	(Mapleston et al., 2009)
Reunion	6	31	No	(Mahé et al., 2022)

Outcome: Excellent local life history data was available for *V. louti* (Table 53).

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

Parameter	Value	SE	Local	Source	Notes
L_∞	43.7	0.97	Yes	(Schemmel & Dahl, 2023)	
k	0.28	0.020	Yes	"	
t_0	-0.2	0.13	Yes	"	
a	0.0140	8.93e-4	Yes	---	From biosampling data
b	3.07	0.0179	Yes	---	"

Parameter	Value	SE	Local	Source	Notes
L_{50}	26.0	0.43	Yes	(Schemmel & Dahl, 2023)	
$L_{\Delta 50}$	35.5	0.33	Yes	“	
t_{max}	17	1.3	Yes	“	Variance estimated from sample size (Nadon, 2017)

Acknowledgments

We greatly appreciate the Guam Biosampling Program staff, Guam Division of Aquatic and Wildlife Resources staff, fishers, and fish vendors of Guam who contributed to the collection of biological samples and data presented in this technical memo. We would like to specifically thank the NOAA Pacific Islands Fisheries Science Center Life History Program, including Eva Schemmel, Kristen Dahl, and Erin Reed, who expedited the processing and analyses of samples in order to provide growth and maturity parameter estimates for several Guam BMUS for inclusion in this technical memo. We would like to recognize additional staff at the Pacific Islands Fisheries Science Center for their contributions to the writing of this report and the information and analyses presented herein: Felipe Carvalho and Marc Nadon.

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