

Insights into the dietary composition and conservation challenges of the Chilean eagle ray (*Myliobatis chilensis*) in the port of Chancay, Lima

Aportes sobre la composición dietaria y los desafíos de conservación de la raya águila chilena (*Myliobatis chilensis*) en el puerto de Chancay, Lima

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Citar como: Yapur-Pancorvo, A. L., and Pinilla García, F. (2025). «Insights into the dietary composition and conservation challenges of the Chilean eagle ray (*Myliobatis chilensis*) at the port of Chancay, Lima». *South Sustainability*, 6(2), e127.
DOI: 10.21142/SS-0602-2025-e127

Artículo recibido: 15/4/2025
Revisado por pares
Artículo aceptado: 25/6/2025



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ABSTRACT

The Chilean eagle ray (*Myliobatis chilensis*) is a vulnerable batoid mesopredator frequently caught as bycatch in Peruvian artisanal fisheries. Despite sustained landings at ports such as Chancay, the species remains unmanaged and poorly studied from an ecological perspective. In this study, we analyzed the stomach contents from twenty-four specimens landed at the port of Chancay during the winter of 2021, in order to establish baseline data on the local trophic ecology. Ten prey taxa were identified, with the red squat lobster (*Pleuroncodes monodon*) dominating all dietary indices (%PW = 89.35; %PSIRI = 63.59), indicating a marked benthic foraging pattern. Polychaetes and teleost eggs constituted relevant secondary prey. Although statistical comparisons were not conducted, due to seasonal sampling limitations, the consistent predominance of *P. monodon* suggests dietary stability under current fishing pressure. These results indicate a benthic dietary pattern under current conditions in Chancay, which may reflect localized prey availability, raising key concerns regarding habitat sensitivity. In a context of increasing fishing intensity and coastal development, dietary studies provide critical early signs of local ecosystem stress and constitute a practical basis for designing targeted conservation measures.

Keywords: trophic ecology, benthic predators, artisanal fisheries, conservation planning

RESUMEN

La raya águila chilena (*Myliobatis chilensis*) es un batoideo mesopredador vulnerable, frecuentemente capturado como pesca incidental en las pesquerías artesanales del Perú. A pesar de los desembarques sostenidos en puertos como Chancay, la especie permanece sin manejo específico y escasamente estudiada desde una perspectiva ecológica. Este estudio analizó el contenido estomacal de 24 ejemplares desembarcados en el puerto de Chancay durante el invierno de 2021, con el objetivo de generar datos de línea base sobre su ecología trófica local. Se identificaron 10 taxones presa, con la múnida (*Pleuroncodes monodon*) como especie dominante en todos los índices dietarios (%PW = 89.35; %PSIRI = 63.59), lo que indica un marcado patrón de forrajeo bentónico. Los poliquetos y los huevos de peces teleosteos constituyeron presas secundarias relevantes. Si bien no se realizaron comparaciones estadísticas debido a la limitación estacional del muestreo, la constante predominancia de *P. monodon* sugiere estabilidad dietaria bajo la actual presión pesquera. Estos resultados confirman un patrón alimentario bentónico para *M. chilensis* en Chancay, posiblemente reflejo de la disponibilidad localizada de presas, y plantean preocupaciones clave sobre la sensibilidad del hábitat. En un contexto de creciente intensidad pesquera y desarrollo costero, los estudios dietarios ofrecen señales tempranas críticas del estrés ecosistémico local y constituyen una base práctica para el diseño de medidas de conservación específicas.

Palabras clave: ecología trófica, depredadores bentónicos, pesca artesanal, planificación de la conservación



Introduction

Globally, elasmobranchs, including rays, have experienced pronounced population decline over recent decades, primarily due to overfishing, habitat degradation and insufficient management (Dulvy *et al.*, 2014; Pacoureau *et al.*, 2021). In many species, particularly within the genus *Myliobatis*, declines have exceeded 70%, increasing the risk of extinction and prompting IUCN Red List status changes (Dulvy *et al.*, 2021). These trends underscore the urgent need for species-specific ecological data to support conservation initiatives, particularly in data-deficient regions such as the Southeast Pacific.

Rays of the order Myliobatiformes are generally considered benthic or demersal predators, feeding predominantly on invertebrates such as mollusks and crustaceans (Jacobsen and Bennett, 2013; Segura-Cobeña, 2017). Species of the genus *Myliobatis* exhibit morphological adaptations, such as flattened bodies and paved teeth, which favor durophagy and benthic foraging (Summers, 2000; Crofts and Summers, 2014). However, some species also consume demersal or pelagic teleosts (Navia *et al.*, 2011), and their diet may vary depending on life stage, sex or seasonal prey availability (White *et al.*, 2004; Sommerville *et al.*, 2011).

The trophic role of *M. chilensis* remains insufficiently defined. While some studies classify it as a benthic predator (Torres, 1978), others suggest a benthopelagic strategy (Castañeda, 1994; Segura-Cobeña, 2017; Manrique and Mayaute, 2017; Peña-Cutimbo *et al.*, 2025). Ontogenetic dietary shifts, observed in related species such as *M. californica* (Gray *et al.*, 1997), suggest that diet may vary according to size or developmental stage (Jacobsen and Bennett, 2013; Molina and López-Cazorla, 2015). With a trophic position ranging from levels 3 to 4, *M. chilensis* may act as a secondary consumer, linking benthic prey to higher predators within the marine food web (Segura-Cobeña, 2017; Silva-Garay *et al.*, 2018).

Like many elasmobranchs, the life-history traits displayed by *M. chilensis* include slow growth, late maturity and low fecundity, increasing its vulnerability to overfishing (Bonfil, 1994). Although previously listed as «Data Deficient,» the species is now classified as «Vulnerable» by the IUCN (IUCN, 2020), reflecting rising concern over population decline and unregulated exploitation.

In Peru, batoids, including *M. chilensis*, are commonly caught as bycatch in artisanal purse-seine fisheries targeting species for direct human consumption. Although often not reported in official landing statistics, recent studies have documented frequent interactions and incidental captures of *Myliobatis* spp. in these fisheries (Peña-Cutimbo *et al.*, 2024). Institutional initiatives such as the Fishery Improvement Project (FIP) for the Peruvian anchovy fishing industry have also acknowledged bycatch

of rays and other elasmobranchs, highlighting the need for ecosystem-based management approaches and improved monitoring (CeDePesca, 2024). Despite these efforts, the extent of *M. chilensis* exploitation remains poorly documented, and it may be the case that landings are retained for local consumption or sold in informal markets.

National landing records reflect growing exploitation pressure. As illustrated in Figure 1, reported ray landings have shown interannual variability, with a tendency towards decline, since the 1990s, despite ongoing fishing activity; however, these patterns appear to reflect population depletion rather than improved regulation.

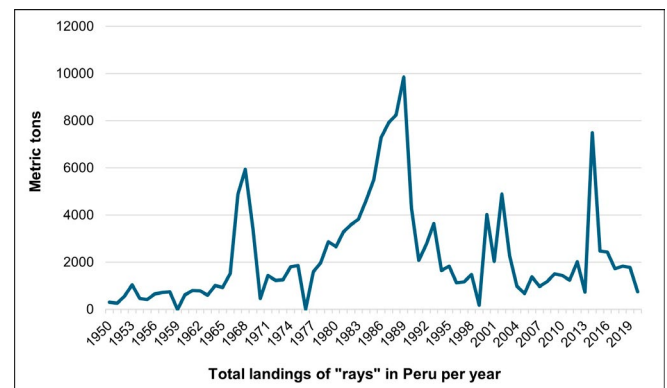


Figure 1. Reported total landings of rays (Batoidea) for direct human consumption in Peru from 1950 to 2020 (in metric tons). Peaks during the late 1980s and early 1990s are followed by a marked and sustained decline in more recent decades, likely driven by reduced population abundance rather than changes in fishing activity. (Adapted from fisheries data disclosed by PRODUCE through a public information request, as reported by INFOPES, 2022.)

Chancay exemplifies these national issues at a local level. As one of Peru’s most active artisanal fishing ports, it imposes substantial pressure on coastal ecosystems, including benthic habitats that support batoid prey species (PRODUCE, 2023). Between 2017 and 2022, more than 246,000 kg of *M. chilensis* were landed at this port alone (IMARPE, 2022), and yet the species remains unmanaged, with no monitoring of catch trends, size distribution or reproductive status. The conversion of Chancay into a mega-port raises additional concerns regarding benthic habitat disruption and prey depletion. Figure 2 shows a marked post-2019 decline in local landings, possibly indicating overexploitation.

In this context, dietary studies provide insight into the vulnerability of species interaction with the environment, and responses to ecological stressors such as climate change or resource depletion (Navia *et al.*, 2007; Heithaus *et al.*, 2008). In heavily fished ecosystems such as Chancay, predators can exert top-down control over food webs and shifts in their diet may serve as early indicators of ecosystem imbalance (Heithaus *et al.*, 2008). Benthic foraging rays often depend on specific prey types, whose

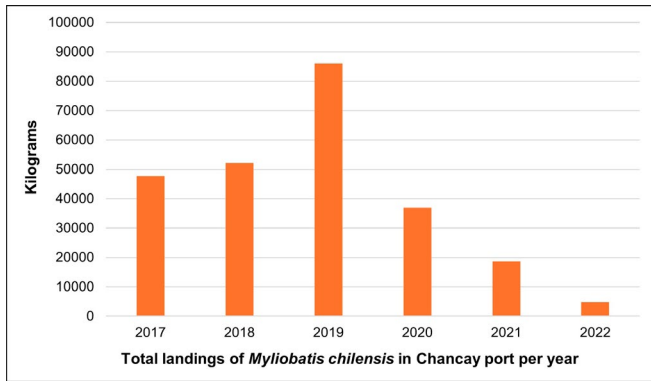


Figure 2. Annual landings (in kilograms) of *Myliobatis chilensis* reported at the port of Chancay (Lima, Peru) from 2017 to 2022. The peak in 2019 is followed by a significant decline, which may reflect local depletion, reduced effort or gaps in reporting. (Adapted from fisheries data disclosed by PRODUCE through a public information request, as reported by INFOPES, 2022.)

decline could potentially destabilize energy intake and trophic roles (Segura-Cobeña, 2017; Yapur-Pancorvo *et al.*, 2023); however, observed dietary variation across seasons and ontogeny suggests that *M. chilensis* may also exhibit trophic plasticity (Peña-Cutimbo *et al.*, 2025).

In data-limited fisheries, stomach content analysis provides a non-invasive method for inferring ecological roles, trophic dependencies and habitat associations (Ferretti *et al.*, 2013). Trophic data can serve as an early-warning indicator of environmental stress, particularly where formal stock assessments are absent (Becerril-García *et al.*, 2022).

The aim of this study was to characterize the dietary composition of *M. chilensis* by analyzing the stomach contents of individuals landed at the port of Chancay during the winter of 2021. By identifying dominant prey groups and evaluating trophic structure, this research contributes baseline data for improving the understanding of the ecological role of *M. chilensis* in Peruvian coastal waters.

Materials and methods

Sample collection

Twenty-four specimens of *M. chilensis* were obtained from artisanal fisheries operating at the port of Chancay (Huaral, Lima; 11°35'08" S, 77°16'24" W) on July 21 2021, during the winter season. Sex was determined based on the presence of claspers in males and their absence in females. For each individual, total length (TL ± 0.5 cm), disc width (DW ± 0.5 cm) and total/gutted weight were recorded. The stomachs were extracted from each individual, and their contents were preserved in 70% ethanol and transported to the Universidad Científica del Sur laboratory for subsequent dietary analysis.

Although the samples taken correspond to a single sampling event, they provide valuable preliminary insights into the diet of *M. chilensis* under current fishing pressures in Chancay.

Stomach content analysis

The stomach contents were inspected visually under a stereomicroscope. In order to evaluate the diet of *M. chilensis*, the degree of stomach fullness was calculated using the Stomach Fullness Index (SFI), based on the ratio of gut content weight to body weight (Franco and Bashirullah, 1992). In addition, the Vacuity Index (VI) was calculated as the percentage of empty stomachs relative to the total number of stomachs analyzed, thereby providing an indicator of overall feeding activity during the sampling period.

Prey items were identified to the lowest possible taxonomic level using identification keys for fish (Chirichigno and Velez, 1998) and stomatopods (Salgado-Barragán and Hendrickx, 1986), as well as recognition guides for crustaceans (Moscoso, 2013), fish otoliths (García-Godos, 2001) and squid beaks (Xavier and Chernel, 2009).

Dietary composition was quantified using the following indices:

- Prey-specific numerical abundance (%PN): the percentage of prey items of a given taxon relative to the total number of prey items, calculated only from stomachs where that taxon occurs.
- Prey-specific weight contribution (%PW): the percentage of total prey weight represented by a given taxon, based on stomachs where the prey item occurs.
- Frequency of occurrence (%FO): the proportion of non-empty stomachs in which a given prey item is found, expressed as a percentage.

These were then integrated into the Prey-Specific Index of Relative Importance (%PSIRI), following the methodology proposed by Brown *et al.* (2012). The %PSIRI is calculated as:

$$\%PSIRI_i = \%FO_i \times \left(\frac{\%PN_i + \%PW_i}{2} \right)$$

Where:

- %FO_i is the frequency of occurrence of prey «i».
- %PN_i is the prey-specific numerical abundance of prey «i».
- %PW_i is the prey-specific weight contribution of prey «i».

This composite index provides a robust and non-redundant measure of trophic importance, by combining how often prey is consumed with its proportional contribution by number and weight. This integrative measure offers critical insights into prey selection and

trophic plasticity, which are essential for assessing the ecological role of species and their conservation status.

Due to the limited sample size and lack of seasonal replication, no inferential statistical tests were performed in order to assess variation by sex or size class. Results were interpreted descriptively, emphasizing dominant prey items and overall dietary structure.

Results

Synthesis of findings on dietary composition

Sampling overview

A total of twenty-four specimens of *M. chilensis* were obtained from artisanal landings at the port of Chancay on June 21 2021. The sample included ten females and fourteen males. Disc width ranged from 53.5 cm to 120 cm, and total length from 32 cm to 86.5 cm. All the stomachs contained identifiable prey, resulting in a VI of 0%, indicating active foraging across all individuals. Most of the stomachs were classified as half-full, based on the SFI, suggesting consistent feeding activity during the sampling period.

Dietary composition

A total of ten prey taxa were identified in the stomach contents of *M. chilensis* (Table 1). The most frequently occurring item was the red squat lobster (*Pleuroncodes monodon*), followed by polychaetes, unidentified teleost eggs, and actinopterygian fish. These items showed the highest values across prey-specific indices. Other taxa identified included pagurids, bivalves, calanoid copepods, cephalopods, and macroalgae from the phyla Chlorophyta and Rhodophyta.

Table 1 summarizes the dietary composition based on frequency of occurrence (%FO), prey-specific numerical abundance (%PN), prey-specific weight contribution

(%PW) and the prey-specific index of relative importance (%PSIRI).

Discussion

Interpretation of dietary patterns

The dietary composition observed in *Myliobatis chilensis* points to a benthic foraging strategy, with a marked reliance on the red squat lobster (*Pleuroncodes monodon*). This species dominated all prey-specific indices, displaying the highest values in numerical abundance (%PN = 45.21), gravimetric contribution (%PW = 89.35) and frequency of occurrence (%FO = 87.5), resulting in a %PSIRI of 63.59. This integrated index confirms *P. monodon* as a key dietary item for *M. chilensis* during the sampling conducted on July 21 2021. Its predominance aligns with its position as a highly abundant, energy-rich macroinvertebrate in the Humboldt Current System (Yapur-Pancorvo *et al.*, 2023).

Polychaetes and actinopterygian eggs also contributed significantly to the diet, with %PSIRI values of 16.70 and 11.14, respectively. These items likely serve as secondary dietary components, consistent with the generalist benthic-feeding behavior previously reported for *M. chilensis* and other myliobatid rays along the Peruvian coast (Coasaca-Céspedes *et al.*, 2018; García and Mantarí, 2019). The remaining taxa (pagurids, bivalves, calanoids, cephalopods and algal fragments) displayed lower frequencies and contributions, with %PSIRI below 5%. These are interpreted as incidental or opportunistic prey, likely consumed during non-selective benthic foraging.

Although the elevated %PSIRI of *P. monodon* may point to dietary specialization, such patterns should be interpreted with caution. It is plausible that this dominance may reflect local prey abundance rather than narrow trophic preference. In fact, *Myliobatis* species are known for their trophic plasticity, adapting their diet

Table 1. Dietary composition of *Myliobatis chilensis* based on prey-specific indices.

Phylum	Class	Order	Family	Species	%FO	%PN	%PW	%PSIRI
Annelida	Polychaeta	-	-	<i>Polychaeta</i> spp.	41.67	28.75	45.44	16.70
Arthropoda	-	-	-	Unidentified arthropods	12.5	30.19	18.56	3.29
Arthropoda	Copepoda	Calanoida	-	Unidentified calanoids	8.33	7.41	0.66	0.36
Arthropoda	Malacostraca	Decapoda	Munididae	<i>Pleuroncodes monodon</i>	87.5	45.21	89.35	63.59
Arthropoda	Malacostraca	Decapoda	Paguridae	Paguridae	20.83	21.76	0.36	2.49
Mollusca	Bivalvia	-	-	Unidentified bivalves	8.33	41.67	0.2	1.88
Mollusca	Cephalopoda	-	-	Unidentified cephalopods	4.17	10	0.57	0.24
Chordata	Actinopterygii	-	-	<i>Actinopterygii</i> spp.	37.5	54.83	0.18	11.14
Chlorophyta	-	-	-	Unidentified chlorophytes	4.17	10	0.32	0.23
Rhodophyta	-	-	-	Unidentified rhodophytes	4.17	2.86	0.45	0.07

Note. %FO = Frequency of occurrence, %PN = Prey-specific numerical abundance, %PW = Prey-specific weight contribution, %PSIRI = Prey-specific Index of Relative Importance, as defined by Brown *et al.* (2012).

in response to prey availability and habitat conditions (Coasaca-Céspedes *et al.*, 2018; Castañeda, 1994).

The predominance of benthic items in this winter sample indicates a demersal feeding pattern during colder months. However, seasonal variation in diet has been reported previously, including increased consumption of pelagic prey such as *Engraulis ringens* in warmer periods or different geographic contexts (Castañeda, 1994), offering further evidence of trophic flexibility. This variability is aligned with generalist feeding behavior and may reflect seasonal changes in prey availability, ontogenetic dietary shifts and spatial heterogeneity in resource distribution.

Although statistical comparisons across sex or size classes were not conducted, due to the modest sample size and lack of seasonal replication, the recurrent presence of dominant prey across individuals suggests a relatively consistent dietary pattern at the time of sampling (July 21 2021). This reinforces the classification of *M. chilensis* as a mesopredator with a trophic level of approximately 4.1, linking benthic invertebrates to higher-level consumers (Segura-Cobeña, 2017).

Regional context of decline and ecological relevance

Beyond individual-level dietary insights, the regional ecological context provides further perspective on the species' conservation needs. The dietary patterns of *M. chilensis* in Chancay reflect broader concerns regarding the conservation status of elasmobranchs throughout the Southeast Pacific. Regional assessments have documented steep declines, often exceeding 70%, in several ray populations, as a result of overfishing, habitat degradation and the absence of effective management (Dulvy *et al.*, 2021; Pacoureau *et al.*, 2021). Although these studies do not explicitly report population trends for *Myliobatis* spp., they highlight the vulnerability of demersal batoids with similar ecological and life-history traits. In this context, the marked drop in *M. chilensis* landings reported in Chancay after 2019 may reflect localized depletion rather than reduced fishing effort.

In data-limited fisheries such as those in Peru, ecological assessments, including stomach content analysis, can provide essential insights to support conservation planning and ecosystem-based fisheries management (EBFM). This study offers the first trophic data approach for *M. chilensis* in Chancay, a key artisanal fishing port under increasing anthropogenic pressure. Comparable efforts in Colombia and Mexico have demonstrated the utility of dietary analysis in evaluating habitat dependence and predicting species responses to exploitation (Navia *et al.*, 2011; Fernández-Aguirre *et al.*, 2022). In this regard, trophic information may complement life-history traits and ecological data in the study of species vulnerability in data-limited contexts (Ferretti *et al.*, 2013; Kindsvater *et al.*, 2018).

The identification of *Pleuroncodes monodon* as the dominant prey item reinforces *M. chilensis*' role as a benthic predator within the Humboldt Current System and underscores its ecological dependence on benthic macroinvertebrate communities (Yapur-Pancorvo *et al.*, 2023). These findings, together with morphological traits adapted for durophagy (Crofts and Summers, 2014), position *M. chilensis* as a key functional component in benthic-pelagic coupling within coastal food webs (Ritchie & Johnson, 2009).

Incorporating trophic data into vulnerability assessments can strengthen ecosystem-based fisheries management (EBFM), particularly when combined with life-history and spatial distribution data (Ferretti *et al.*, 2013; Kindsvater *et al.*, 2018). Such integrated approaches are increasingly essential, in order to inform adaptive management strategies for demersal elasmobranchs in the face of environmental changes and escalating anthropogenic pressures.

Conservation outlook and management recommendations

Between 2017 and 2022, artisanal fisheries at Chancay landed over 246,000 kg of *M. chilensis*; however, no species-specific monitoring protocols exist regarding size structure, reproductive condition or catch volume (IMARPE, 2022; PRODUCE, 2023). This reflects a broader lack of regulation for batoid bycatch in Peru, where many non-target species remain outside formal fisheries frameworks (Becerril-García *et al.*, 2022; Tarazona *et al.*, 2003).

Chancay is currently undergoing rapid industrial transformation, with port expansion expected to increase dredging, turbidity and vessel activity; factors known to impact benthic prey communities (PRODUCE, 2023). Comparable environmental disturbances in Baja California have been linked to shifts in eagle ray diets during El Niño events, with rays shifting from benthic invertebrates to pelagic prey sources (Fernández-Aguirre *et al.*, 2022). Although *M. chilensis* exhibits trophic flexibility in some regions (e.g., Coasaca-Céspedes *et al.*, 2018), sustained degradation of benthic prey communities may compromise its foraging efficiency and energy intake.

Despite its contributions, this study is constrained by temporal limitations (single-season, winter sampling) and modest sample size. Soft-bodied prey may also be underrepresented, due to post-capture digestion. Future research should incorporate year-round sampling and complementary techniques, such as stable isotope analysis or DNA metabarcoding, in order to provide more temporally integrated perspectives on trophic dynamics (Ferretti *et al.*, 2013; Becerril-García *et al.*, 2022).

The evident benthic dependence and mesopredatory role of *M. chilensis* underscore the need for habitat-focused conservation measures. Local strategies, such as



catch documentation, size-based regulations and benthic habitat protection, should be co-designed with artisanal fishing communities, in order to foster compliance and integrate traditional ecological knowledge (Becerril-García *et al.*, 2022). Although geographically restricted, the findings offer a valuable baseline for the development of adaptive monitoring frameworks with a trophic focus, aligned with ecosystem-based management in Peru's coastal fisheries.

Author contributions

Ana Lucía Yapur-Pancorvo: Conceptualization, methodology, investigation, data curation, formal analysis, visualization, writing (original draft), writing (revising and editing), project administration.

Francisco Pinilla García: Writing (revising and editing).

Source of financing

This work was supported by the *Carrera de Biología Marina*, Universidad Científica del Sur (*Fondo «Beca Cabieses 2020-22»*, Project Registration N° 420-2020-PRES).

Conflicts of interest

The authors declare no conflict of interest.

Acknowledgements

Special acknowledgement to Pepe Espinoza for his support and guidance during field sampling and laboratory data analysis.

Bibliographic references

- Becerril-García, E. E., Arauz, R., Arellano-Martínez, M., Bonfil, R., Ayala-Bocos, A., Castillo-Géniz, J. L., and Godard-Codding, C. A. (2022).** «Research priorities for the conservation of chondrichthyan in Latin America». *Biological Conservation*, 269, 109535.
- Bonfil, R. (1994).** «Overview of world elasmobranch fisheries». (FAO Technical Paper No. 341). Food and Agriculture Organization of the United Nations.
- Brown, S. C., Bizzarro, J. J., Cailliet, G. M., and Ebert, D. A. (2012).** «Breaking with tradition: redefining measures for diet description with a case study of the Aleutian skate *Bathyraja aleutica* (Gilbert 1896)». *Environmental Biology of Fishes*, 95, 3-20.
- Castañeda, J. (1994)** *La pesquería artesanal y biología pesquera de especies de importancia económica en la caleta de San José (febrero 1991 - septiembre 1992)*. [Bachelor's thesis. Universidad Nacional Mayor de San Marcos].
- CeDePesca. (2024).** «Peruvian Anchovy (Indirect Human Consumption) Fishery Improvement Project: Progress update - December 2024». Available at: <https://cedepesca.net/promo/peruvian-anchovy-indirect-human-consumption/>
- Chirichigno, N., and Vélez, J. (1998).** *Claves para identificar peces marinos del Perú*. Callao: Instituto del Mar del Perú (IMARPE).
- Coasaca-Céspedes, J. J., Segura-Cobeña, E., Montero-Taboada, R., Gonzalez-Pestana, A., Alfaro-Córdova, E., Alfaro-Shigueto, J., and Mangel, J. C. (2018).** «Análisis preliminar de los hábitos alimentarios de batoideos pertenecientes a los géneros *Mobula* y *Myliobatis* en el Norte de Perú». *Revista de Biología Marina y Oceanografía*, 53(3), 367-374.
- Crofts, S. B., and Summers, A.P. (2014).** «How to best smash a snail: The effect of tooth shape on crushing load». *Journal of the Royal Society Interface*, 11(92), 20131053. Available at: <https://doi.org/10.1098/rsif.2013.1053>
- Dulvy, N. K., Fowler, S. L., Musick, J. A., Cavanagh, R. D., Kyne, P. M., Harrison, L. R., and White, W. T. (2014).** «Extinction risk and conservation of the world's sharks and rays». *eLife*, 3, e00590.
- Dulvy, N. K., Pacoureau, N., Rigby, C. L., Pollom, R. A., Jabado, R. W., Ebert, D. A., and Simpfendorfer, C. A. (2021).** «Overfishing drives over one-third of all sharks and rays toward a global extinction crisis». *Current Biology*, 31(21), pp. 4773-4787.
- Fernández-Aguirre, E., Galván-Magaña, F., Sánchez-González, A., González-Armas, R., Abitia-Cárdenas, L. A., Elorriaga-Verplancken, F. R., and Torres-García, R. Q. (2022).** «Changes in the feeding habits of the bat ray *Myliobatis californica* (Gill 1865) during climatic anomalies off the west coast of the Baja California Peninsula, Mexico». *Regional Studies in Marine Science*, 53, 102462.
- Ferretti, F., Worm, B., Britten, G. L., Heithaus, M. R., and Lotze, H. K. (2013).** «Patterns and ecosystem consequences of shark declines in the ocean». *Ecology Letters*, 13(8), pp. 1055-1071. Available at: <https://doi.org/10.1111/j.1461-0248.2010.01489.x>
- Franco, L., and Bashirullah, K. M. (1992).** «Alimentación de la lisa (*Mugil curema*) del Golfo de Cariaco, Estado Sucre, Venezuela». *Zootecnia Tropical*, 10(2), pp. 219-238.
- García, L., and Mantarí, P. (2019)** *Hábitos alimentarios de los batoideos de importancia comercial de Pisco - Ica, mayo - septiembre 2019*. [Bachelor's thesis, Universidad Nacional San Luis Gonzaga].
- García-Godos Naveda, I. (2001).** «Patrones morfológicos del otolito sagitta de algunos peces óseos del mar peruano». *Boletín Instituto del Mar del Perú*, 20(1-2), pp. 1-83.
- Gray, A. E., Mulligan, T. J., and Hannah, R.W. (1997).** «Food habits, occurrence and population structure of the bat ray, *Myliobatis californica*, in Humboldt Bay, California». *Environmental Biology of Fishes*, 49(2), pp. 227-238. Available at: <https://doi.org/10.1023/A:1007379606233>.
- Heithaus, M. R., Frid, A., Wirsing, A. J. and Worm, B. (2008).** «Predicting ecological consequences of marine top predator declines». *Trends in Ecology & Evolution*, 23(4), pp. 202-210.
- INFOPE. (2022).** *Raya águila (Myliobatis peruvianus)*. Universidad Nacional Agraria La Molina. Available at: <http://tumi.lamolina.edu.pe/infopes/raya-aguila-myliobatis-peruvianus/>
- Instituto del Mar del Perú (IMARPE). (2022).** «Desembarque de recursos hidrobiológicos en el puerto de Chancay, 2017-2022». Available at: https://sinia.minam.gob.pe/sites/default/files/siar-lima/archivos/public/docs/desembarque_de_recursos_hidrobiologicos_imarpe.pdf
- IUCN. (2020)** *Myliobatis chilensis*. The IUCN Red List of Threatened Species. Available at: <https://www.iucnredlist.org/species/60123/124441181>
- Jacobsen, I. P. and Bennett, M. B. (2013).** «A comparative analysis of feeding and trophic level ecology in stingrays (Rajiformes; Myliobatoidei) and electric rays (Rajiformes: Torpedinoidei)». *PLoS ONE*, 8(8), e71348. Available at: <https://doi.org/10.1371/journal.pone.0071348>
- Kindsvater, H. K., Dulvy, N. K., Horswill, C., Juan-Jordá, M. J., and Mangel, M. (2018)** Overcoming the data crisis in biodiversity conservation. *Trends in Ecology & Evolution*, 33(9), pp. 676-688. Available at: <https://doi.org/10.1016/j.tree.2018.06.004>.
- Manrique, M. R., and Mayaeta, L.F. (2017).** *Hábitos alimentarios de las rayas Pseudobatos planiceps (Garman, 1880), Hypanus dipterurus (Jordan & Gilbert, 1880) y Myliobatis chilensis (Philippi, 1892), en Pisco, Ica, Perú, 2016*. [Bachelor's thesis, Universidad Nacional San Luis Gonzaga].
- Ministerio de la Producción (PRODUCE). (2023).** *Anuario estadístico pesquero y acuícola 2023*. Available at: <https://www.produce.gob.pe>
- Molina, J. M., and Cazorla, A. L. (2015).** Biology of *Myliobatis goodei* (Springer, 1939), a widely distributed eagle ray, caught in northern Patagonia. *Journal of Sea Research*, 95, pp. 106-114. Available at: <https://doi.org/10.1016/j.seares.2014.09.006>
- Moscoso, V. (2013).** «Clave para identificación de crustáceos decápodos y estomatópodos del Perú». *Boletín Instituto del Mar del Perú*, 28(1-2), pp. 8-135.
- Navia, A. F., Mejía-Falla, P. A., and Giraldo, A. (2007).** «Feeding ecology of elasmobranch fishes in coastal waters of the Colombian Eastern Tropical Pacific». *BMC Ecology*, 7, pp. 1-10.
- Navia, A. F., Torres, A., Mejía-Falla, P. A., and Giraldo, A. (2011).** «Sexual, ontogenetic, temporal and spatial effects in the feeding ecology of *Urotrygon rogersi* in the Colombian Pacific Ocean». *Journal of Fish Biology*, 78, pp. 1213-1224.
- Pacoureau, N., Rigby, C. L., Kyne, P. M., Sherley, R. B., Winker, H., Carlson, J. K., and Dulvy, N. K. (2021).** «Half a century of global decline in oceanic sharks and rays». *Nature*, 589(7843), pp. 567-571.
- Peña-Cutimbo, N., Cordero-Maldonado, C., Ortiz-Alvarez, C., Alfaro-Shigueto, J., and Mangel, J. C. (2024).** «Marine megafauna interactions with the Peruvian artisanal purse-seine fleet». *Fisheries Research*, 269, 106878.



- Peña-Cutimbo, N., Córdova-Zavaleta, F., Velarde-Vílchez, M., Jimenez, A., Pingo, S., Ramirez, P., and Alfaro-Shigueto, J. (2025).** «Comparative feeding analysis between the Chilean eagle ray *Myliobatis chilensis* (Philippi, 1982) and the Peruvian eagle ray *Myliobatis peruvianus* (Garman, 1913) from northern Peru». *Regional Studies in Marine Science*, 81, 103915.
- Ritchie, E. G., and Johnson, C.N. (2009).** «Predator interactions, mesopredator release and biodiversity conservation». *Ecology Letters*, 12(9), pp. 982-998. Available at: <https://doi.org/10.1111/j.1461-0248.2009.01347.x>
- Salgado-Barragán, J. and Hendrickx, M. E. (1986).** *Los estomatópodos (Crustacea: Hoplocarida) del Pacífico mexicano*. Publicaciones Especiales Instituto de Ciencias del Mar y Limnología, 227.
- Segura-Cobena, E. (2017).** *Composición de la dieta de la raya águila *Myliobatis chilensis* en la caleta de San José, Región Lambayeque*. [Bachelor's thesis, Universidad Científica del Sur].
- Silva-Garay, L., Pacheco, A. S., and Vélez-Zuazo, X. (2018).** «First assessment of the diet composition and trophic level of an assemblage of poorly known chondrichthyans off the central coast of Peru». *Environmental Biology of Fishes*, 101, pp. 1525-1536. Available at: <https://doi.org/10.1007/s10641-018-0797-0>
- Sommerville, E., Platell, M. E., and Potter, I. C. (2011).** «Partitioning of food resources by four abundant, co-occurring elasmobranch species: relationships between diet and both body size and season». *Marine and Freshwater Research*, 62(1), pp. 54-65. Available at: <https://doi.org/10.1071/MF10164>.
- Summers, A. P. (2000).** «Stiffening the stingray skeleton - An investigation of durophagy in Myliobatid stingrays (Chondrichthyes, Batoidea, Myliobatidae)». *Journal of Morphology*, 243(2), pp. 113-126. Available at: [https://doi.org/10.1002/\(SICI\)1097-4687\(200002\)243:2<113::AID-JMOR1>3.0.CO;2-A](https://doi.org/10.1002/(SICI)1097-4687(200002)243:2<113::AID-JMOR1>3.0.CO;2-A)
- Tarazona, J., Gutiérrez, D., Paredes, C., and Indacochea, A. (2003).** «Overview and challenges of marine biodiversity research in Peru». *Gayana (Concepción)*, 67(2), pp. 206-231. Available at: <https://doi.org/10.4067/S0717-65382003000200009>
- Torres, A. O. (1978).** *Biología y pesquería de *Myliobatis chilensis* en la caleta de San José*. [Bachelor's thesis, Universidad Nacional Pedro Ruiz Gallo, Lambayeque, Perú]. Available at: https://biblioteca.imarpe.gob.pe/opac_css/index.php?lvl=notice_display&id=5328
- White, W. T., Platell, M. E., and Potter, I.C. (2004).** «Comparisons between the diets of four abundant species of elasmobranchs in a subtropical embayment: implications for resource partitioning». *Marine Biology*, 144, pp. 439-448. Available at: <https://doi.org/10.1007/s00227-003-1218-1>
- Xavier, J. C., and Cherel, Y. (2009).** «Cephalopod beak guide for the Southern Ocean». *CCAMLR Science*, 16, pp. 83-106.
- Yapur-Pancorvo, A. L., Frías-Torres, S., Luque-Vásquez, F., and González, M. (2023).** «The red squat lobster *Pleuroncodes monodon* in the Humboldt Current System: From their ecology to commercial attributes as marine bioresource». *Animals*, 13(14), 2279. Available at: <https://doi.org/10.3390/ani13142279>