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Salud del ecosistema e importancia bioecológica de las nutrias (*Lontra felina* y *L. provocax*) (Mustelidae, Lutrinae) en Chile: una revisión

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RESUMEN

Se presentan nuevos antecedentes sobre composición fecal de las nutrias marinas (*Lontra felina* y *L. provocax*) del norte de Chile y Magallanes y se analizan los cambios de la dieta de estas especies a lo largo de la costa del Pacífico sur oriental desde el sur de Perú al extremo austral de Chile. Los datos sobre composición de las heces de *L. felina* del norte de Chile: Punta Patache y de *L. provocax* de los canales y fiordos patagónicos se compararon con datos publicados para aguas continentales de la Araucanía y la costa pacífica del sur de Perú y Chile central. La nutria marina *L. felina*, es uno de los principales depredadores de las comunidades bentónicas del litoral Pacífico suroriental, desde Chimbote en Perú hasta el Cabo de Hornos en Chile, y *L. provocax* representa lo mismo en los ecosistemas de agua dulce de los lagos y ríos araucanos de Chile y Argentina. A pesar de su importancia en el transporte de nutrientes y las redes tróficas de los sistemas que integran, existen pocos estudios sobre su ecología trófica y su participación en los procesos ecológicos. La dieta de las nutrias marinas (*L. felina* y la población marina de *L. provocax*) comprende un amplio espectro de presas, incluyendo peces, crustáceos, moluscos, aves, equinodermos y pequeños mamíferos. En ambos casos, un análisis cuantitativo mostró cambios de especies presa en el gradiente latitudinal, íntimamente relacionados con la zonación biogeográfica de peces y crustáceos de la zona. Las nutrias de la población de agua dulce se alimentan de unas pocas especies de camarones, peces y mejillones de aguas oligotróficas y mesotróficas, y su conservación está necesariamente ligada a la conservación del hábitat de estas presas y su disponibilidad. Ambas especies de nutria se clasifican como especies generalistas y oportunistas en el sentido de depender de una amplia variedad de especies presa que mayoritariamente incluyen

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peces, crustáceos, moluscos, y aves. Con variaciones locales y por sector, ambas especies de nutrias depredan principalmente sobre especies carnívoras y herbívoras, pero también incluyen en menor grado omnívoros, carnívoros y detritívoros, lo cual las sitúa como depredadores tope en la comunidad inter y submareal rocosa.

Palabras clave: *Lontra felina*, *Lontra provocax*, importancia bioecológica, Chile

Ecosystem health and bioecological importance of otters (*Lontra felina* and *L. provocax*) (Mustelidae, Lutrinae) in Chile: a review

ABSTRACT

New data on the fecal composition of sea otters (*Lontra felina* and *L. provocax*) from northern Chile and the Magallanes region are presented, and dietary shifts along the eastern southwestern Pacific coast from southern Peru to the southernmost part of Chile are analyzed. Data on the fecal composition of *L. felina* from northern Chile (Punta Patache) and *L. provocax* from Patagonian channels and fjords are compared with published data for inland waters of the Araucanía region and the Pacific coast of southern Peru and central Chile. The sea otter, *L. felina*, is a top predator in the benthic communities of the southeastern Pacific coast, from Chimbote in Peru to Cape Horn in Chile, and *L. provocax* represents the same in the freshwater ecosystems of Araucanian lakes and rivers in Chile and Argentina. Despite their importance in nutrient transport and the food webs of the systems they comprise, there are few studies on their trophic ecology and their participation in ecological processes. The diet of sea otters (*L. felina* and the marine population of *L. provocax*) comprises a wide range of prey, including fish, crustaceans, mollusks, birds, echinoderms, and small mammals. In both cases, quantitative analysis showed shifts in prey species along the latitudinal gradient, closely related to the biogeographic zonation of fish and crustaceans in the area. Otters in the freshwater population feed on a few species of shrimp, fish, and mussels from oligotrophic and mesotrophic waters, and their conservation is necessarily linked to the conservation of the habitat of this prey and their availability. Both otter species are classified as generalist and opportunistic species, meaning they depend on a wide variety of prey species, primarily including fish, crustaceans, mollusks, and birds. With local and sectoral variations, both otter species prey primarily on carnivores and herbivores, but also include omnivores, carnivores, and detritivores to a lesser extent, making them top predators in the rocky inter- and subtidal community.

Key words: *Lontra felina*, *Lontra provocax*, bioecological importance, Chile

INTRODUCTION

Each species plays an important role in the energy flow of communities, which is reflected in their diet. In this sense, understanding their trophic niche is essential for defining conservation and protection strategies for the ecosystems they comprise. This is especially true for species that function as top predators (high-trophic-level predators) due to their umbrella effect and regulator of the overall stability of these systems. In this capacity, these species are also indicators of the health of the ecosystems they comprise (Crowley & Hodder, 2019). This is the case of the huillín [*Lontra provocax* (Thomas, 1908)]in the continental waters of Chile and Argentina and the Patagonian channels and fjords, and the chungungo [*Lontra felina* (Molina,1782)] on the Pacific coast of Chile and Peru (Apaza & Romero, 2012).

As top predators, these otters help regulate their prey populations, maintain the overall health of the ecosystem, and maintain its resilience to natural (global warming, El Niño/La Niña, etc.) and anthropogenic (introduction of exotic species, aquaculture, fishing, etc.) factors. As generalist predators, otters consume a wide variety of fish and invertebrates, contributing to the balance of the food web. For the same reasons, the increasing settlement of the coastline, adverse anthropogenic impacts, shellfish extraction, and the development of benthic resource management areas contribute to the degradation and fragmentation of the coastal ecosystem and habitat of the huillín and the chungungo. This is without prejudice to the fact that at least the chungungo has some capacity to adapt to changes caused by humans (Gutiérrez *et al*., 2019).

The rocky subtidal ecosystem of the extensive marine coastline of Chile and inhabited by *L. felina*, is structured around kelp forests that along the north-central Chilean coast are mainly composed of two species of Laminariales: *M. integrifolia* Bory, 1826 (syn. *Macrocystis pyrifera* (Linnaeus) C. Agardh, 1820) and *Lessonia trabeculata* (Villouta & Santelices) (Villouta & Santelices, 1984; Hermosilla-Núñez *et al*., 2018). At the Patagonian channels and fjords inhabited by *L. provocax*, the kelp *Macrocystis integrifolia*, growing mainly in areas protected from waves (North, 1971a), presents widely developed forests. *L. trabeculata* is here replaced by *Lessonia flavicans* Bory and *Lessonia vadosa* Searls in austral Chile (Knox, 1960; Skottsberg, 1921, 1941; Santelices & Ojeda, 1984 a, b; Asensi & De Reviers, 2009).

The intertidal zone of the rocky Pacific coast presents a belt of *Lessonia spp*. and *Durvillaea antarctica* (Cham.) Hariot from 30° south, where *D. antarctica* is distributed from Cape Horn (56°S) to 43°S, and *D. incurvata* (Suhr) Macaya is distributed from 43°S to 30°S (Fraser *et al*., 2020). *Lessonia berteroana* Montagne is distributed north of 30°S and *L. spicata* (Suhr) Santelices south of 29°S, (González *et al*., 2012). These kelp species are adapted to cold waters, strong waves and turbulence and are part of an ecosystem with higher rates of primary productivity (Velimirov *et al*., 1977) and considered engineer species (Jones *et al*., 1994) or niche builders (sensu Levins & Lewontin, 1985) since their body structures supply areas for reproduction, food and refuge for many vertebrate and invertebrate species (Tegner & Dayton, 2000; Steneck *et al*.,, 2002; Villegas *et al*. 2007).

In this ecosystem, both the chungungo and the marine population of the huillín must interact with other predators (birds, fish, echinoderms, crustaceans, mollusks, among others), regulating diversity and the ecological stability of the system. Also introduced species (mink, murids, and salmonids) that, together with human actions (coastal modification, extraction of benthic resources, and establishment of management areas), alter the stability of the system (Thomas *et al*., 2017; Medina-Vogel *et al*., 2024). Numerous very local assessments have been carried out

on this subject (Acevedo *et al*., 2019; Gutiérrez *et al*., 2019); however, a more integrative vision that would facilitate more comprehensive decision-making on biodiversity conservation and the effective protection of Chilean otters is lacking.

As Hermosilla-Núñez *et al*. (2018) pointed out, in recent years kelp beds and other associated fishery resources (e.g. loco, limpets, sea urchins, edible tunicates, octopus, rock fishes) have been heavily exploited, inducing drastic changes in the benthic communities at spatial and temporal scales (Ortiz & Levins, 2017) that have not considered the repercussions on the key species of these systems (e.g. *Lontra felina*, *Lontra provocax*, *Cephalorhynchus eutropia*, *Poikilocarbo gaimardi*, among others).

In these cases the identification of focal species [i.e., keystone, umbrella and flagship species *sensu* Paine (1969)] in ecosystems (e.g., kelp forests) is fundamental and would help to understand the composition, status and function at a community and ecosystem levels (Menge *et al*., 1994; Navarrete & Menge, 1996; Power *et al*., 1996; Simberloff, 1998) and could contribute with relevant information for the design of complementary or alternative biodiversity management and monitoring conservation programs (Lambeck, 1997; Noss, 1999; Simberloff, 1998).

The concept of "keystone species" was coined by Paine (1969), extended by Power *et al*. (1996), and widely used for different species (e.g., Delibes-Mateos *et al*., 2007; Estes *et al*., 1998; Gaymer & Himmelman, 2008; Menge *et al*., 1994; Münzbergova & Ward, 2002). The huillín and the chungungo stand out in this case as good candidates as indicators of the health of the rocky coastal ecosystem given their generalist nature of high trophic level (Biffi & Iannacone, 2010).

However, vast areas of the Peruvian and Chilean coast are affected by the exploitation of resources that are part of the chungungo's diet (Sielfeld & Castilla, 1999), bycatch, and habitat pollution, among other factors (Biffi & Iannacone, 2010). In fact, Álvarez & Medina (2008) estimate that its population could decline by up to half in the next decade.

The situation of the huillín is not very different, including increasing pollution and destruction of its habitat in continental freshwater systems (Medina *et al*., 2021) and growing conflicts with the development of aquaculture, population of the coastal edge, benthic resource management areas and artisanal fishing in the case of southern channels and fjords (Sielfeld *et al*., 2024).

In this scenario, the central objective of this study is to highlight the ecological importance of the huillin and its role in freshwater ecosystems of Chile and of the chungungo and the marine population of huillin in the kelp bed communities along the Peruvian Chilean Pacific coast and the Patagonic fjords and channels.

In this way it is also intended to generate a support base for monitoring and conservation programs of both otter species in Chile, support for biodiversity management in the protected areas of the "Chilean Protected Area System" (SNAP) and for the improvement of management of artisanal fishery strategies inside the "Benthic Resource Management Areas of Chile", its "Preliminary Site Characterization" (CPS), and their "Environmental Information" (INFA) and "Management and Exploitation Plan".

MATERIALS AND METHODS

Data

Feeding data of otters from Tarapacá Region, Northern Chile, and Magallanes Region, Austral Chile were analyzed together with information on feces composition and prey remains associated with latrines, denning sites and/or trails from preexisting studies on feeding of huillin and chungungo in the marine and continental environments from southern Peru to Cape Horn (Table 1). Different information sources are identified throughout the text and Table 1. The background on the collection of feces and food remains, their conservation and treatment and analysis are also detailed in the indicated sources, so they are omitted here. In the cases of chungungo from the Tarapacá and Magallanes Regions and of huillin in Magallanes Region, the presence of fish in the feces was established by otolith identification and scales by comparison with a reference collection.

The prey size of Magellan samples was estimated from otolith length/total fish length ratios developed during this study for *Patagonotothen longipes*, *P. tessellata*, *P. wiltoni* and *P. cornucola* for this purpose by Sielfeld (1984). For *Eleginops maclovinus*, the growth curve of Guzmán & Campodónico (1973) was used.

The species identification of prey from Tarapacá: Punta Patache and Magallanes were based on Marincovich (1973), Basly (1982) and Forcelli (2000) for mollusks, Chirichigno (1970), Retamal (1981) and Guzmán (1998) for crustaceans and for fish Lloris & Rucabado (1991) and Zama & Cárdenas (1984).

Information on maximum sizes that reach prey species such as crustaceans and mollusks was taken from the website https://decapodos-chile.linnaeus.naturalis.nl/, for mollusks by Zelaya (2009), for fish and for echinoderms by Navarrete *et al.* (2008). In Appendix: Table 1 a summary of maximum sizes, distribution and feeding of the prey species indicated in this work is given.

The prey size of crustaceans is expressed as cephalothorax length (C.l.) and/or cephalothorax width (C.w.); in gastropods size is the length of the spiral + the final turn, in patellogastropods the maximum shell width, and in pelecypods the valve length. In echinoderms the diameter was considered, and in fish, the total length (T.l.), standard length S.l. and standard deviation (sd.).

To discuss the participation of huillín and chungungo in the balance of the trophic web, the feeding patterns of the preyed species are summarized in Appendix, Table 1. The information was extracted from Meyer *et al.* (2009) for crustaceans and Espoz *et al.* (2004); Osorio (2002), Poveda (2006), Zelaya (2009) and Aldea *et al.* (2019) for mollusks. In the case of fish, Muñoz *et al.* (2002) was used for *Bovichthus*, Duarte & Moreno (1981) for *Harpagifer*, Cancino & Castilla (1988) for *Sicyases*, Pardo-Gandarilla *et al.* (2004) for *Gobiesox*, González & Chong (1997) for *Paralichthys*, Chong *et al.* (2006) for *Genypterus*, Barria (2007) for *Odontesthes*, Orrego & Mendo (2005) for *Trachurus*, Muñóz & Ojeda (2000) for *Scartichthys*, Meléndez (1989) for *Prolatilus*, Cáceres *et al.* (1993) for *Aplodactylus*, Fariña *et al.* (2000) for *Girella*, Vélez (1981) for *Labrisomus*, Várgas *et al.* (1999) and Berrios & Vargas (2004) for rockfishes from the far north of Chile. Additional sources of information on individual species are detailed in Pérez-Mattus *et al.* (2017 b). For special species information sources are indicated in Table 1 (Appendix).

Data arrangement

Fecal analysis has been the most widely used method in different otter species (Melquist & Hornocker, 1983; Reid *et al*., 1994; Spinola & Vaughan, 1995; Quadros & Monteiro-Filho, 2001; Copp & Roche, 2003; Somers & Nel, 2003; Watson & Lang, 2003; Medina-Vogel *et al*., 2004; Parker *et al*., 2005; Sielfeld, 1984; Chehebar, 1985; Chehebar *et al*., 1986; Medina, 1996, 1997, 1998; Choupay, 2003).

For the present case published data and new original data on the fecal composition of huillín and chungungo are presented in the form of synoptic tables, expressed as "percentage frequency of occurrence" (number of feces in which a prey type appears X 100/total number of feces) (Erlinge, 1969; Rowe-Rowe, 1977; Krebs, 1998; Sielfeld, 1989; Medina, 1997, 1998). This method is considered an excellent tool to obtain an overview of the relative importance of prey in the diet and its comparison with previous work (Carss & Parkinson, 1996).

CHUNGUNGO		
Region	Site	Source
Perú	Morro Sama, Vila-Vila	Biffi & Iannacone, 2010; Mangel *et al*., 2010
Tarapacá	Punta Patache	Sielfeld, 2003
Atacama	Pan de Azúcar	Ostfeld *et al*., 1889
Coquimbo	Choros Island	Villegas, 2002
Valparaiso	Los Molles	Castilla & Bahamonde, 1979
Concepción	Caleta Chome & San Vicente	Poblete *et al*., 2019
Los Rios	Valdivia	Medina, 1995; Medina *et al*., 2004; Solari, 2024
Los Rios	Pucatrihue	Cordova *et al*., 2009
Los Lagos	Guafo Island	Núñez, 2014
Los Lagos	Chiloé Island	Cabello, 1978, 1983; Ostfeld *et al*., 1989
Aysén	Palena	Sanino & , 2016; Raimilla, 2020
Magallanes	Island sectors	Sielfeld, 1980, 1990
HUILLIN		
Region	Site	Source
Chile	Rio Toltén	Parra, 2006
Freshwaters	Rio Allipen	Medina *et al*., 2021
	Boroa	Gonzalez & Medina, 2006
	Valdivia	Franco *et al*., 2011, 2013
	Chiloé	Espinosa, 2012
Argentine	Nahuelhuapi	Chehebar,, 1985; Chehebar *et al*., 1986
Freshwaters		Cassini *et al*., 2009
		Fasola, 2009; Fasola *et al*., 2006, 2009
Aysén & Magallanes	Channels & Fjords	Chupay, 2003; Sanino & Meza, 2016 Sielfeld, 1984

Table 1: Studies on feeding of huillin and chungungo from Southern Peru and Chile.

The treatment given by different authors to their feeding information is highly variable and makes comparative analysis difficult, by using very diverse recording systems and indices. Poblete *et al.* (2019) indicates a species appearance index PA = total specimens of a prey species/ total prey specimens x 100, and a frequency index of occurrence FA = feces with the prey species/ total feces x 100. For the Peruvian localities, Mangel *et al.* (2010) refer to percentages based on visual records of prey capture by chungungos in Morro Sama and Vila-Vila, while Pizarro-Neira (2014) indicates a percentage for each prey species calculated on the total prey identified in the feces of the same sectors.

Solari (2024) uses this same method to express the fecal composition of chungungo in Punta Cachos, Caleta Arrayán, Totoralillo, Calfuco, Pilolcura and Corral, and Poblete *et al.* (2019) for Caleta Chome and San Vicente. Biffi & Giannaccone (2010) use for Sama & Quebrada Burros in Peru a frequency of occurrence index FO = feces with one prey item/total feces x 100 (=here treated as FA). This same index is also applied by Villegas (2002) for Isla Choros, Choupay (2003) for the Golfo Elefantes/Laguna San Rafael sector in Aysén, Sielfeld (2006) for the Magallanes region and Núñez (2014) for Isla Guafo.

The size of the study areas, the number of fecal samples analyzed, and the duration of the study periods were also varied, so this information must be evaluated and interpreted with caution (Hostos & Valqui 2024). As a reference number it must be considered that Trites & Joy (2005) concludes a minimal sample size of 94 scats, an amount that is not reached in many cases.

It should also be considered that fecal composition analysis underestimates larger prey items and overestimates smaller ones (Carss & Parkinson, 1996; Jacobsen & Hansen, 1996), which is especially important when assessing the presence of fish in feces. For this reason, this analysis also includes food items found around latrines, feeding sites, trails, and denning sites, prey items that, due to their size, are generally consumed on land.

This underestimation is especially significant when the content is expressed as a percentage of the prey found in feces, as there is a greater likelihood of distinguishing arthropod prey (chelae, claws, carapaces, rostrums, etc.) compared to the difficulty of identifying fish species, which are consequently considered a collective prey item "undetected fish."

For huillín in the channels of Northern Patagonia (Aysén Region), reference will be made to the information presented by Choupay (2003) for the Elefantes Gulf/San Rafael Lagoon sector in Aysén. The Lucac River and Ofqui Isthmus feces, which do not correspond to a marine environment, were excluded from this information. In addition, some systematic reordering was performed in Choupay's original data table (op. cit.). The data are presented in four sectors: I.- Exploradores Bay; II.- Huillines Cove; III.- Gualas Cove, and IV.- San Rafael Lagoon (Table 2; Fig. 1).

For huillín and chungungo in the channels of Southern Patagonia (Magallanes Region), the information previously analyzed by Sielfeld (1984, 1989) is complemented with new information on prey sizes and subdivided into subsectors given the large latitudinal extension of the area. For huillín feces, 8 sectors were considered: Fallos Channel, Trinidad Channel, Concepción and Inocentes Channels, Esteban Channel, Uribe Channel, Queen Adelaide Archipelago/entrance to the Strait of Magellan, Xaultegua Gulf/Strait of Magellan/Pedro Channel, Beagle Channel and Año Nuevo Sound (Table 2; Fig. 1). For chungungo the data reported by Sielfeld (*op. cit.*) were rearranged in 3 sectors: Stosch Island/Nelson Strait, Skyring Island/Stewart Island and Año Nuevo Sound/Cape Horn Archipelago.

For the comparative analyses of the present note, considering the great variability in the sample sizes, the data were normalized as percentages and expressed as "species appearance index" (PA) to express diversity and niche breath, and as "frequency index of occurrence" (FA) to express consumption.

Geographic coverage of the data

Regarding the diet of the huillín in freshwaters of south-central Chile, information was included for Valdivia: Linque, Pullafquén and Quatro Dos Rivers; Quellón: Rio Negro and Lake Chaiguata; Cucao: Colecole River and Lake Cucao; Ensenada: Petrohué River and Lake Todos los Santos presented by Medina (1991), the coastal wetland associated with the Boroa River according to González & Medina (2006) and the summary for the area between the Cruces River and Chiloé (39°50'S-43°00'S) by Medina (1997).

For chungungo, information was considered from Morro Sama and Vila-Vila (Mengel *et al.*, 2011; Pizarro-Neira, 2014) Quebrada Burros and Vila-Vila (Biffi & Iannacone, 2010), Punta Patache (Sielfeld: original unpublished information), Pan de Azúcar (Ostfeld *et al.*, 1989), Punta Cachos, Caleta Arrayanes and Totoralillo (Solari, 2024); Choros Island (Villegas, 2002), Chome and San Vicente (Poblete *et al.*, 2019), Valdivia (Medina, 1995; Medina *et al.*, 2004; Solari 2024), Pucatrihue (Córdova *et al.*, 2009), Los Molles (Castilla & Bahamondes, 1979), Chiloé (Ostfeld *et al.*, 1989; Solari, 2024), Guafo Island (Núñez, 2014); Magellan sectors of I. Stosch-Nelson Strait,

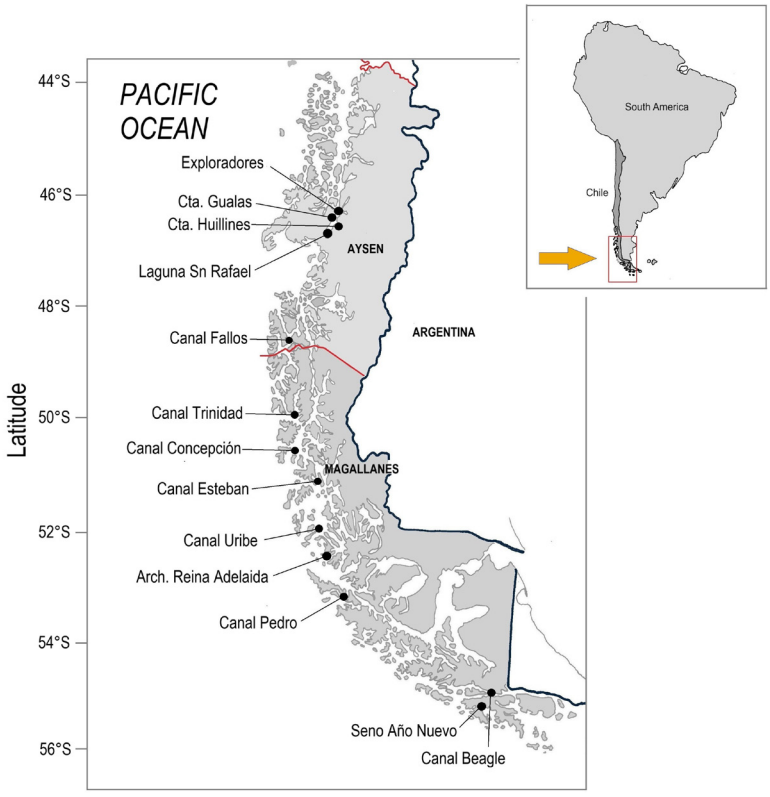


Fig. 1: Huillin feces collecting sites in Patagonian channels and fjords. [Sources: Choupay (2003) Aysén; Sielfeld (1984, 1989) Magallanes].

AYSEN REGION			
Zones	Sectors	Sites	Reference coordinates
I	Bahía Exploradores	Punta de Entrada	46°17'11-16''S/ 73°31'40-51''W
II	Estero Cubquelan: Cta. Huillines	Interior de la Caleta	46°19'39''S/73°35'49''W
		Punta	46°18'49-57''S/73°35'23-29''W
		Bahía	46°29'46-48''S/73°45'46-48''W
III	Golfo Elefantes; Cta. Gualas	Punta Huidobro	46°27'29-52''S/ 73°44'13''-45'02''W
		Punta García	46°30'40-48''S/ 73°46'01-02''W
		Sector noroeste	46°39'33''S/74°00'48''W
		Sector oeste	46°39'48''S/74°00'59'W
IV	Laguna San Rafael	Sector noreste	46°36'46-60''S/73°51'31-52'50''W
		Sector sureste	46°44'04-08''S/73°54'51-56''W
		Sector sur	46°44'19-40''S/73°55-57'W
MAGALLAN REGION			
Zones	Sectors	Sites	Reference coordinates
I	Canal Fallos	Isla Wellington: Seno Erhardt	48°41'12,80''S/74°47'54,90''W
		Isla Wellington: Seno Triple	48°56'40,81''S/74°26'22,00''W
		Isla Stosch: Puerto Orella	49°06'19,88''S/75°35'50,32''W
II	Canal Trinidad	Isla Mornington: Puerto Nuevo	49°35'29,86''S/75°23',11,31''W
		Isla Wellington: Seno Breackout	49°37'47,17''S/74°28'42,24''W
		Isla Mornington: Puerto Alert	49°37'47,17''S/74°28'42,24''W
		Isla Wellington: Fiordo Wide	49°57'58,77''S/74°32'15,19''W
III	Canal Concepción	Isla Madre de Dios	50°19'17,07''S/75°18'37,57''W
		Isla Farrell: extremo norte	50°43'03,67''S/74°44'50,76''W
	Canal Inocentes	Isla Chatham	50°51'25,54''S/74°07'33,42''W
		Isla Farell: extremo sur	50°52'10,01''S/74°03'17,90''W
IV	Canal Esteban	Isla Gonzalez Videla	51°11'56,19''S/74°27'21,03''W
V	Canal Uribe	Isla Vidal Gormáz	52°07'34,12''S/74°46'56,67''W
	Archipiélago Reina Adelaida	Isla Pérez	52°11'49,94''S/74°18'28,92''W
VI	Entrada Estrecho de Magallanes	Isla Manuel Rodríguez	52°40'15,88''S/73°44'57,08''W
		Isla Desolación: Seno Damián	50°43'03,67''S/74°44'50,76''W
VII	Golfo Xaultegua	Isla Riesco: Golfo Xaultegua	53°02'33,42''S/72°52'28,15''W
		Isla Riesco: Brazo Núñez	53°17'04,63''S/72°31'33,51''W
	Estrecho de Magallanes	Isla Riesco: Seno Fanny	53°03'27,33''S/72°18'33,64''W
	Canal Pedro	Isla Santa Inés: Seno Smyth	53°48'46,56''S/72°12'57,58''W
		Isla Guardián Brito: Seno Vaccaro	54°14'45,93''S/72°24'43,89''W

Table 2: Zones and sectors of Aysen and Magellan regions with scat analyses of huillin in marine habitats. Sources: Choupay (2003) in Aysen; Sielfeld (1984, 1989) in Magallanes.

		Isla Capt.Aracena: Canal Agwalisnán	54°14'25,49''S/71°37'42,18''W
		Isla Capt.Aracena: Caleta Beaubasin	54°04'13,14''S/71°03'02,61''W
		Tierra del Fuego: Seno de Agostini	54°27'06,00''S/70°24'22,00''W
VIII	Canal Beagle	Tierra del Fuego: Caleta Olla	54°56'27,15''S/69°09'06,15''W
		Isla Hoste: Caleta Awaiakirrh	55°00'29,04''S/69°01'28,05''W
		Isla Diablo	54°57'26,26''S/69°07'12,62''W
		Isla Gordon	54°58'12,76''S/69°07'46,23''W
IX	Seno Año Nuevo	Isla Hoste: Seno Moneraye	55°12'16,38''S/69°16'15,63''W
		Isla Hoste: Seno Carfort	55°11'14,60''S/68°46'17,83''W
		Isla Dumont D'Urville	55°23'00,00''S/69°05'00,00''W

I. Skyring - I. Stewart, Seno Año Nuevo - Cape Horn Archipelago (Sielfeld, 1984, 2006; new data). Fig. 2 shows a detail of the localities and sectors mentioned above.

The data of Núñez (2014) treating in separate form feces of 2012 and 2013 were integrated and treated here as a whole. The fecal analysis data from Sanino & Meza (2016) for the Aysén region could not be integrated into the present analysis because they do not separate between *L. felina* and *L. provocax* and make no reference to prey species, generally considering only major groups (vertebrates, crustaceans, mollusks and echinoderms).

For sites and localities, the original Spanish names are maintained according to the official cartography of the Hydrographic Service of the Chilean Navy (SHOA).

Statistics

The Horn's Index of Similarity (R_0) was used to measure food niche overlap between otter species and between zones. The index was selected because it is nearly independent of sample size and can be calculated from relative abundances (proportions or percentages) (Krebs, 1998).

$$R_0 = \frac{\Sigma (p_{ij} + p_{ik}) \log (p_{ij} + p_{ik}) - \Sigma p_{ij} \log p_{ij} - \Sigma p_{ik} \log p_{ik}}{2 \log 2}$$

Where: p_{ij} = Proportion resource i of the total resources utilized by species j
p_{ik} = Proportion resource i of the total resources utilized by species k
log = log base *e*

The Open Access Package PAST 2.17 – Data Analysis for Palentologists by Hammer (2024) was used for the calculations and development of the corresponding dendrograms and cophenetic correlation index (CCI) to evaluate the fidelity of the dendrograms (ranges from -1 to 1). Values close to 1 indicate a strong agreement between the dendrogram structure and the original data distances, meaning the clustering accurately represents the data's inherent relationships.

Niche breath was measured by applying a Levin's Measure (B) and Shannon-Wiener Measure (H') to the prey matrix. In both cases the index was standardized (B_A, H'est) to express them on a scale from 0 to 1.

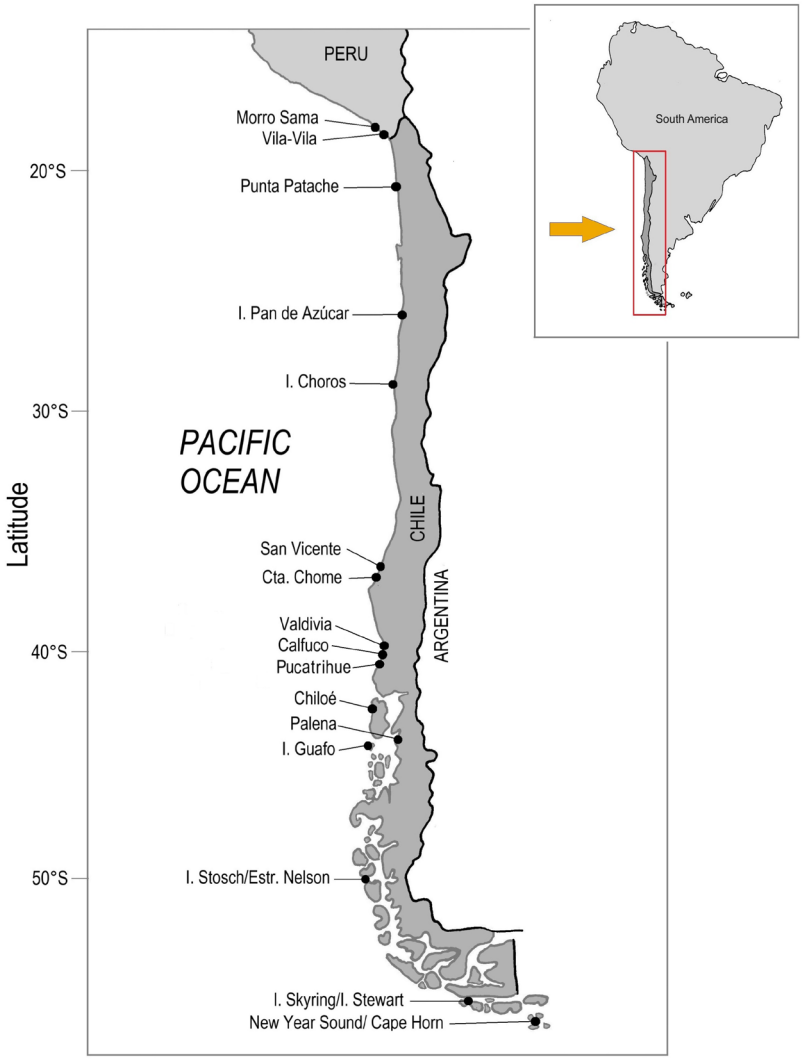


Fig. 2:
Sites with records of feces and feeding remains of chungungo between Southern Peru and Southern Patagonia.

Both indexes were applied because of conceptual differences between them. Shannon-Wiener measure gives more weight to rare resources, while Levin's measure gives more weight to abundant resources (Krebs, 1999).

Levin's index: $B = 1/\Sigma p_j^2$
Standardized Levin's index: $B_A = (B-1)/(n-1)$
Shannon-Wiener Index: $H' = -1\sum np_j \log(p_j)$
Standardized Shannon-Wiener Index: $H'_{est} = \log(n)\ H'$
Where: P_j = Proportion of individuals in resource j
n = number of resources
log = log base *e*

Analyses were conducted with Python using the *easystats* collection of packages (Lüdecke *et al.*, 2019/2023).

RESULTS

a. Feeding information type and indices

Feeding data of huillin and chungungo presented as "species appearance index" (PA) and "frequency index of occurrence" (FA) lead to different assessments of the feeding behavior of otters (Fig. 3 a. b). The FA/PA Pearson´s correlations for fish and crustaceans, both huillín and chungungo, show weak correlations (≤ 0.59); p ≥0.09), except crustacea FA/PA of chungungo (r = 0.962; p 0 0.0005). Consequently, for trophic niche breadth and/or consumption analysis, PA and FA values cannot be mixed, and the series should be analyzed separately.

b. Trophic spectrum

b.1. The huillín in freshwater systems

In the freshwaters of south-central Chile, this species primarily consumes crustaceans of the genera *Aegla*, *Samastacus*, and *Parastacus* (FA frequency index 50-100%) and fish of the genera *Percichthys* and *Cheirodon* (FA frequency index 13.6-75.0%) (Table 3).

Other less frequent items found in feces include the native fish *Percilia gillissi*, *Diplomystes camposensis* and *Galaxias maculatus*, the introduced *Cyrinus carpio*, *Oncorhynchus mikiss* and *Salmo trutta*, mollusks The food remains associated with latrines, trails and dens (Table 4) include species previously mentioned as part of the feces (Table 3).

The wetland of the Boroa River (38°45'07"S/72°44'05W) and Rio Cruces (39°49'S,

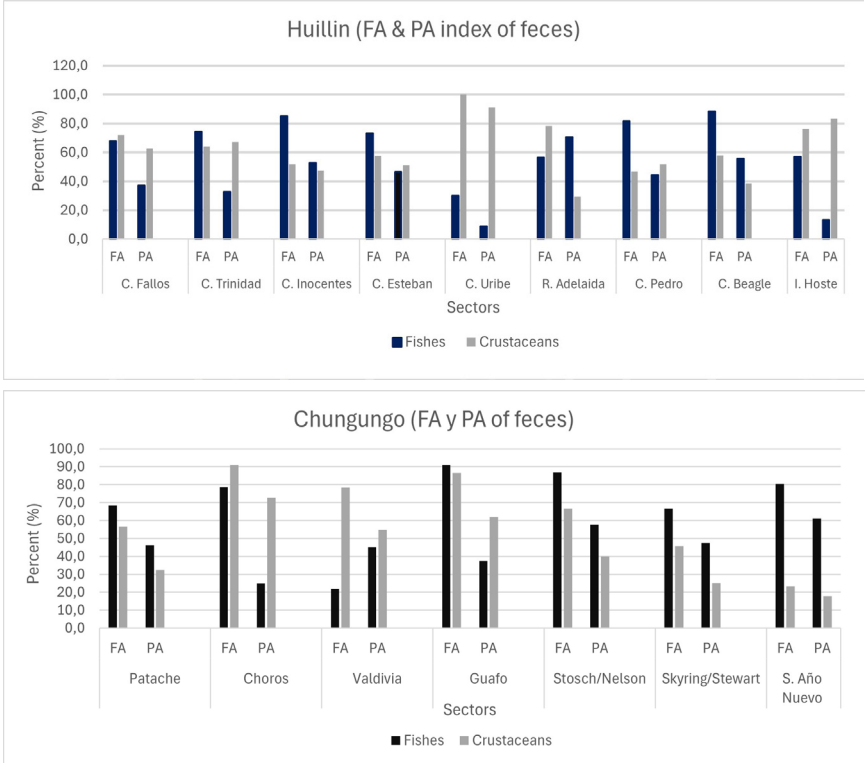


Fig. 3: Feces composition of huillin and chungungo along latitudinal gradients. (PA= "species appearance index"; FA "frequency index of occurrence").

73°15'W) represent special cases, including *Caudiverbera caudiverbera* in lentic sectors, and in the case of the Boroa coastal wetland *Munida subrugosa* and *Odontesthes regia*, species that probably enter from the sea to estuarine sectors and *Hemigrapsus crenulatus* that is typical of the estuarine environments of New Zealand and Chile (Vega *et al.* 2018) between Iquique and the Strait of Magellan (20°-54°S) (Meyer *et al.* 2009).

Niche breath at the Rio Cruces Natural Sanctuary was estimated by Franco *et al.* (2013) in 0.625-0.647 (mean = 0.635, ds. 0,0091) suggesting a trophic niche with dependence on only a few food items.

The food remains associated with latrines, trails and dens (Table 4) including the species previously mentioned as part of the feces (Table 3).

b.2. The huillin in fjords and channels

Huillín scats from the Aysén channels and fjords included 21 prey items (Table 5, 6). Fish were represented in 93.10% FA of the scats, crustaceans and mollusks 68.10% and 18.10% respectively (Table 5). Along the studied gradient (46°18'S-46°44'S) the fish varied between 83.33-97.67% (mean=92.91%), 25.58-100.00% (mean=76.22%) for crustaceans and 0.00-25.00% (mean=16.31%) for mollusks (Table 5). Fish intake focused on Notothenidae species (67.24% of the scats) among which 13.8% corresponded to *Patagonotothen* sp. and 0.86% to *Eleginops maclovinus*. Of lesser importance are *Centroscyllium granulosum* (35.34%), Zoarcidae (16.38%) and *Bovichtus chilensis* 8.62%. The crustacean intake is characterized by 36.21% *Acanthocyclus albatrossis* and 31.9% *Cancer coronatus*, and 9.48% *Hemigrapsus crenulatus*.

Considering the prey species spectra by sectors (Table 6), Estero and Golfo Elefantes

ITEMS (Expressed as FA)	Rio Linque (a)	Rio Pullafquén (a)	Lago Todos los Santos(a)	Rio Petrohue (a)	Rio Colecole (a)	Lago Cucao (a)	Lago Chaiguata (a)	Rio Negro (a)	Rio Puelo (a)	Humedal Boroa (b)	Santuario Rio Cruces (c)	39°50' – 43°00'S (d)*
Parastacus pugnax/ nicoletti	50.00									20.00		2
Samastacus spinifrons	100.00	50.00	88.63	50.00	100.00		84.21	75.00		63.90	85.86	116
Hemigrapsus crenulatus								100.00				4
Grimothea subrugosa								25.00				1
Aegla sp.	50.00		50.09	83.33	72.72	100.00	36.84	75.00	100.00		32.46	119
Crustacea indet.										14.00		
Crustacean general	100.00	50.00	100.00	100.00	100.00	100.00	84.21	100.00	100.00	97.90		243
Oncorhynchus mikiss.										0.50	1.13	
Salmo trutta											.418	
Galaxias maculatus												1

Table 3: Percentage frequency of occurrence (FA) of huillín feces in freshwater systems of Chile. (Sources: a = Medina (1991); b = González & Medina (2006); c = Franco *et al.* 2013 (the data represent a mean of 4 seasonal series); d = Medina (1997)(*= expressed as specimens).

Cheirodon australe	75.00									3
Percichthys trucha			13.63	50.00				0.50	4.83	14
Percillia gillissi										23
Diplomystes camposensis									4.25	
Cyprinus carpio	75.00	50.00								4
Odontesthes regia.								0.50		
Perciformes indet.								1.00		
Peces indet.					18.18	21.05	50.00	18.60	5.54	14
Fishes general	75.00	50.00	13.63	50.00	18.18	21.05	50.00	21.60	23.94	59
Caudiverbera caudiverbera								3.60	4.40	
Anfibia indet.								2.10		
Anfibians general								5.70	4.40	
Diplodon chilensis						15.78				
Chilina sp.						5.26		2.10		
Austrodiscus twomeyi								2.10		
Mollusks general						21.04		4.20		
Rattus norwegicus									4.08	
Abrothix sp.								0.50		
Rodentia indet.								0.50		
Mammals general								1.00	4.08	
Aves indet.								1.00	1.06	
Birds general								1.00	1.06	

(sectors I-III) show high similarity (>0.8; Fig. 3), separated from Laguna San Rafael (sector IV) (similarity < 0.5; Fig. 3). The latter is also distinguished by a lower consumption of *Centroscyllium granulatum* (6.98%; >57.8% in other stations), 32.6% of feces with *Patagonotothen* spp. (<4.5% in other stations), 19.1% of *Bovichtus chilensis* [10% in Caleta Exploradores (sector I) and absent in other sites] and *Calliclinnus* spp. 32.6% (<4.5% in the remaining stations) (Table 5). In addition, the feces of Laguna San Rafael (sector IV) include the fishes *Aphos porosus*, *Sprattus fuegensis*, *Normanichthys crookeri*, *Sebastes capensis* and Bleniidae indet.

In the Magellanic channels and fjords twenty-one food items were recognized in feces. Fish were represented in 74.83% FA of feces and crustaceans in 61.38% (Table 6). However, along the latitudinal gradient (48°41'S–55°23'S), fish varied between 30.00–88.37% (mean = 68.27%) and 46.94–100.00% (mean = 67.24%) for crustaceans (Table 6).

The fish intake expressed as FA focused mainly on species of the genus *Patagonotothen*, generally present in 35.17% of the feces, with a range between 19.05-51.16% according to sector (mean = 31.65%) (Table 6). This item was confirmed in scats along the entire latitudinal gradient

(48°41'S-55°23'S), except in the Uribe channel/ Vidal Gormáz island (Sector V). The other species (*Cottoperca gobio*, *Eleginops maclovinus*, *Trachurus murphyi*, *Salilota australis*, *Sebastes capensis*, *Sprattus fuegensis*) were only detected punctually in feces from one or two sectors (Table 6).

ITEMS (percent (%) composition by site)	Rio Linque (a)	Río Pullafquén (a)	Lago Todos los Santos (a)	Rio Petrohue (a)	Rio Colecole (a)	Lago Cucao (a)	Lago Chaiguata (a)	Rio Negro (a)	Rio Puelo (a)
Samastacus spinifrons	20.00								
Aegla abtao			42.50	100.00					
Crustaceans totals	20.00			100.00					
Diplodon chilensis	80.00	100.00	71.42	18.75			100.00		100.00
Chilina sp.			42.85	75.00					
-Macrocyclis peruvianus			7.14						
Mollusks totals	80.00	100.00	71.42	75.00			100.00		100.00
Larus dominicanus							7.69		
Birds totals							7.69		

Table 4: Food remain percentage reported around trails, latrines and denning sites of huillín in continental sectors of Chile (Source: a= Medina, 1991).

	AYSEN REGION						
Species	Totals		I	II	III	IV	Mean
	n	%	%	%	%	%	%
Centroscyllium granulatum	41	35.34	55.00	53.33	47.83	6.98	40.79
Notothenidae	78	67.24	10.00	20.00	30.43	76.74	34.29
Patagonotothen spp.	16	13.79		3.33	4.38	32.56	10.07
Bovichtus chilensis	10	8.62	10.00			19.05	7.26
Harpagifer bispinnis	2	1.72			8.70		2.18
Eleginops maclovinus	1	0.86				2.33	0.58
Calliclinus spp.	16	13.79		3.33	4.38	32.56	10.07
Normanichthys crookeri	1	0.86				2.33	0.58
Sebastes capensis	1	0.86				2.33	0.58
Genypterus sp	1	0.86	5.00				1.25
Aphos porosus	1	0.86				2.33	0.58
Galaxias maculatus	1	0.86				2.33	0.58
Sprattus fuegensis ?	3	2.59				6.98	1.75
Blenniidae sp.	2	1.72				4.65	1.16
Zoarcidae sp.	19	16.38	15.00	10.00	26.07	16.28	16.84
Fishes totals	108	93.10	95.00	83.33	95.65	97.67	92.91

Table 5: Percentage frequency of occurrence (FA) in feces of huillín from fjords, sounds and channels of Aysen Region (Source: Choupay, 2003). (I-IV = sectors according to table 2; n= total feces with item).

Petrolisthes violaceus	2	1.72		3.33		2.33	1.42
Acanthocyclus albatrossis	42	36.21	65.00	16.67	73.91	13.95	42.38
Hemigrapsus crenulatus	11	9.48	20.00	13.33	13.04		11.59
Cancer coronatus	37	31.90	60.00	73.33	13.04		36.59
Crustaceans totals	79	68.10	100.00	96.67	82.61	25.58	76.22
Mytilus edulis	5	4.31	5.00			9.30	3.58
Mytilus chorus	2	1.72				4.65	1.16
Mollusks totals	21	18.10	25.00	10.00		30.23	16.31
Feces by sector (n)	120	100.00	20	30	23	47	30.00

Of the crustaceans found in the feces, *Grimothea gregaria* was the most important, present in 33.45% FA of the feces (range 4.00-100.00%; mean = 37.89%) (Table 6). Of the remaining prey species, *Cancer edwardsi* was present in 28.00% and 2.56%, respectively, of the feces from the northern part of the study area (sectors I and II), and *Acanthocyclus albatrossis*, observed in 52.00% of the feces from +sector I. *Campylonotus vagans* was most abundant around the western exit of the Strait of Magellan (Zone VII; 18.37%) and the Beagle Channel (Zone VIII; 20.93%). It was also present around the Trinidad channel (Zone II; 2.56%) and Año Nuevo Sound (Zone IX; 4.76%). *Lithodes santolla* distributed from Chiloe to the south (Retamal 1981), was intermittently present in the fecal samples from the northern and southern sectors of the studied area [I – III and VII-IX (Fallos channel to Inocentes channel)], presence in 1.85-16.00% and 10.20-33.33% of the feces respectively.

The food remains associated with trails, latrines, and dens of huillin (Table 8) revealed consumption two species of sea urchins (*Pseudoechinus magellanicus* and *Loxechinus albus*) and five species of birds (*Spheniscus magellanicus*, *Leucocarbo magellanicus*, *Lophonetta specularioides*, *Tachyeres pteneres*, and *Chloephaga hybrida*). Mollusks were represented by nine gastropod species (*Fisurella picta*, *F. oriens*, *Argobuccinum sp.*, *Plaxiphora aurata*, *Acanthina monodon*, *Tegula atra*, *Odontocymbiola magallanica*, *Trophon geversianus*), and two pelecypods (*Clamys patagonica* and *Mytilus edulis*). No consumption of *Concholepas concholepas* was found.

The most abundant species in the food remains (Tables 7, 8) were the subtidal species *Fisurella picta* (34.0% of remains) and the intertidal species *Nacella magallanica* (23.5% of remains). *Mytilus edulis* and *Lithodes santolla* contributed 7.8%, *Plaxiphora aurata* 6.5%, *Argobuccinum magellanicum* 3.3%. Other 15 species had percentages below 2%. In addition, a very low incidence of *Loxechinus albus* (0.7%) was noted and only recorded in the Backout inlet, the northernmost sector of the study area (Table 7) and 5.2% of birds present on the coast of the Magellanic channels.

Niche overlap expressed by the Horn Index (Fig. 4) between Aysén region and Magellanic region (Tables 5 & 6) reveals differences (similarity distance <1.5). The distance results from the presence in Aysén of prey species of central Chilean distribution (e.g. *Bovichtus chilensis*, *Calliclinus* spp., Blennidae indet., *Normanichtys crookeri*, *Cancer coronatus*) whose southern distribution range borders Aysén and northern Magallanes, and in Magellanic species with an austral distribution, such as *Patagonotothen* spp., *Cottoperca gobio*, *Salilota australis*, *Grimothea gregaria*, and *Lithodes santolla* (Table 5).

Niche overlap of FA values between the nine fjord and channel sectors of Magallanes (48°41'S–55°23'S) show sectors II-IV, VI-VII structured as close group at a similarity distance >0.75 (Fig. 4). Sector I (Fallos channel) distinguish from the main group (similarity around 0.45) by a

	Totals		I	II	III	IV	V	VI	VII	VIII	IX	Mean
Species	N	%	%	%	%	%	%	%	%	%	%	%
Patagonotothen spp.	102	35.17	44.00	38.46	31.48	26.92		39.13	34.69	51.16	19.05	31.65
Cottoperca gobio	1	0.34		2.56								0.28
Eleginops maclovinus	3	1.03		2.56		3.85			2.04			0.94
Trachurus murphyi	1	0.34			1.85							0.21
Salilota australis	2	0.69							2.04	2.36		0.49
Sebastes capensis	1	0.34								2.36		0.26
Sprattus fuegensis	7	2.41			3.70				10.20			1.54
Pisces indet.	65	22.41	20.00		48.15	46.15	30.00	17.39		34.88		21.84
Fishes totals	217	74.83	68.00	74.36	85.19	73.08	30.00	56.62	81.63	88.37	57.14	68.27
Cancer edwardsi	8	2.76	28.00	2.56								3.40
Halicarcinus planatus	1	0.34			1.85							0.21
Acanthocyclus albatrossis	18	6.21	52.00	7.69	1.85				2.04			7.06
Lithodes santolla	25	8.62	16.00	2.56	1.85				10.20	16.28	33.33	8.91
Paralomis granulosa	8	2.76						4.35	2.04		28.57	3.88
Grimothea gregaria	97	33.45	4.00	48.72	46.30	57.69	100.00	34.78	14.29	20.93	14.29	37.89
Campilonotus vagans	21	7.24		2.56				4.35	18.37	20.93	4.76	5.66
Crustacea indet.	5	0.4			5.56					4.65		1.13
Crustaceans totals	178	61.38	72.00	64.10	51.85	57.69	100.00	78.26	46.94	58.14	76.19	67.24
Aves indet.	7	2.41				3.85			2.04	9.30	4.76	2.22
Rodentia indet.	1	0.34							2.04			0.23
Feces by sector (n)	290	100.00	25	39	54	26	10	23	49	43	21	32.22

Table 6: Frequency index of occurrence (FA) = percentage of feces with an item, calculated on the total number of feces, of huillín feces from fjords, sounds and channels of the Magallan Region (Sources: Sielfeld, 1984, 1989). (I-IX = sectors according to table 2; n= total feces with item).

	Totals (n)		I	II	III	IV	V	VI	VII	VIII	IX	Mean
Prey species	N	%	%	%	%	%	%	%	%	%	%	
Patagonotothen spp.	104	24.0	25.58	28.85	20.88	16.28		52.94	32.69	31.43	13.33	
Cottoperca gobio	1	0.2		1.92								
Eleginops maclovinus	3	0.7		1.92		2.33			1.92			
Trachurus murphyi	1	0.2			1.10							
Salilota australis	2	0.5							1.92	1.43		
Sebastes capensis	1	0.2								1.43		
Sprattus fuegensis	6	1.4			2.20				7.69			
Pisces indet.	65	15.0	11.63		28.57	27.91	8.82	23.53		21.43		
Fishes totals	183	42.3	37.21	32.69	52.75	46.51	8.82	70.59	44.23	55.71	13.33	
Cancer edwardsi	9	2.1	16.28	3.85								
Halicarcinus planatus	1	0.2			1.10							
Acanthocyclus albatrossis	18	4.2	30.23	5.77	1.10				1.92			
Lithodes santolla	25	5.8		1.92	1.10				9.62	10.00	23.33	
Paralomis granulosa	8	1.8						5.88	1.92		20.00	

Table 7: Appearance index (PA) = percentage of total number of specimens of a prey species, calculated on the total number of prey specimens, of huillín feces from fjords, sounds and channels of the Magallan Region (Sources: Sielfeld, 1984, 1989). (I-IX = sectors according to table 2; n= total feces with item).

Grimothea gregaria	156	36.0	9.30	55.77	40.66	51.16	91.18	17.65	21.15	12.86	36.67
Campilonotus vagans	20	4.6						5.88	17.31	12.86	3.33
Crustacea indet.	5	1.2			3.30					2.86	
Crustaceans totals	242	55.9	62.79	67.31	47.25	51.16	91.18	29.41	51.92	38.57	83.33
Aves indet.	7	1.6				2.33			1.92	5.71	3.33
Rodentia indet.	1	0.2							1.92		
Total specimens (n)	433	100.0	43	52	91	43	34	17	52	70	30

Sector	*Species*	N	Anatomical structures
	Lithodes santolla	3	29 mm (right chela); part of rostrum
I	*Genypterus sp.*	3	Skulls; length 152 mm; 161 mm; 158 mm.
	Acanthocyclus albatrossis	1	Cephalothorax fragments; immesurable
	Fisurella picta	1	45 mm
	Fisurella oriens	1	39 mm
	Cancer edwardsi	3	Cephalothorax fragments; immesurable
	Argobuccinum ranelliforme	1	Immesurable
	Plaxiphora aurata	1	Immesurable
	Chloephaga hybrida	1	Leg bone fragments; complete sternum; adult
	Loxechinus albus	1	Diameter 30 mm
	Nacella magallánica	2	Shell length 49mm and 44 mm
	Fisurella picta	3	Shell length 60 mm; 89 mm; 43.5 mm
II	*Mytilus edulis*	7	Valve length 73.6; 66.3; 22.7; 69.0; 42.0; 34.0; 35.0 mm
	Plaxiphora aurata	1	Length 94 mm
	Acanthina monodon	1	Incomplete last turn; immesurable
	Tegula atra	1	Incomplete shell; immesurable
	Aulacomya ater	1	Valve length 100 mm
	Fisurella picta	10	Shell length 24; 78; 73; 74; 65; 52; 75; 80mm; 2 immesurable
III	*Nacella magallánica*	10	Shell length 43; 55; 53; 47; 46; 43; 39; 43; 38; 26 mm
	Cottoperca gobio	1	Body skin with scales; fresh musculature
	Plaxiphora aurata	2	Length 80 mm
	Nacella magallánica	3	Shell length 56; 52; 62 mm
VI	*Lithodes santolla*	4	Cephalothorax length 93 and 87 mm;
	Salilota australis	1	Part of tail; dorsal vertebrae; skull bones; immesurable
	Chloephaga hybrida	1	Abundant feathers; humerus of adult specimen
	Osteichthyes indet.	2	Skull and vertebrae fragments; indeterminable & immesurable
	Fisurella picta	1	Shell length 79 mm
VII	*Phalacrocoracidae sp.*	1	Bone fragments and rostrum; adult specimen
	Nacella magallánica	5	Shell length 48; 45; 45; 46; 45 mm
	Plaxiphora aurata	1	Length 85 mm

Table 8: Species, number and size of huillin food remains found around trails, latrines and denning sites of fjords, channels and sounds of the Magallan region (Sources: Fuente: Sielfeld, 1984, 1989; Sectors I–IX according to table 2; n= specimens).

	Lithodes santolla	2	Cephalothorax fragments; leg segments
	Tachyeres pteneres	1	Sternum of adult specimen
	Lithodes santolla	2	Part of cephalotorax and legs; immedible
	Pseudoechinus magallanicus	1	Broken plates and spines
	Mytilus edulis	5	Valve length 73; 66; 67; 66; 50 mm
	Plaxiphora aurata	5	Length 91; 92; 71; 87 mm; immesurable plate fragments
	Argobuccinum magellanicum	5	Shell length 82; 86; 88; 82; 92 mm
VIII	*Odontocymbiola magallánica*	1	Shell length 75 mm
	Trophon geversianus	1	Shell length 49 mm
	Nacella magellanica	15	Shell length 60; 50; 2; 41; 51; 56; 61; 47; 49; 39; 57; 33; 49; 69; 43 mm
	Fisurella picta	37	Shell length 91; 87; 85; 90; 95; 94; 64; 89; 73; 90; 88; 93; 97; 87; 90; 81; 84;88; 91; 79; 62; 80; 72; 96; 100; 100; 92; 84; 94; 95; 95; 88; 103; 90; 87; 87; 81 mm
	Zygoclamys patagónica	1	Valve length 92 mm
	Leucocarbo magellanicus	2	Skull, coxae and tibia of an immature; 1 adult skull
	Lophonetta specularioides	1	Right humerus of adult
	Spheniscus magellanicus	1	Sternum plus 2 coracoides; adult specimen
IX	*Lithodes santolla*	1	Cephalothorax length 96 mm
	Nacella magallánica	1	Shell length 37 mm

Species	I	II	III	IV	V	VI	VII	VIII	IX	n	%
Nacella magallanica		2	10			3	5	15	1	36	23.53
Fisurella picta	1	3	10				1	37		52	33.99
Fisurella oriens	1									1	0.65
Mytilus edulis		7						5		12	7.84
Aulacomya ater		1								1	0.65
Clamys patagonica								1		1	0.65
Plaxiphora aurata	1	1	2				1	5		10	6.54
Argobuccinum magellanicum								5		5	3.27
Argobuccinum ranelliforme	1									1	0.65
Acanthina monodon		1								1	0.65
Tegula atra		1								1	0.65
Trophon geversianum								1		1	0.65
Odontocymbiola magallanica								1		1	0.65
Mollusks totals	4	16	22			3	7	70	1	123	80.39
Lithodes Santolla	3					4	2	2	1	12	7.84
Acanthocyclus albatrossis	1									1	0.65
Cancer edwardsii	3									3	1.96

Table 9: Summary of food remains of huillin found around trails, latrines and denning sites of fjords, channels and sounds of the Magallan region (Data from table 6).

Crustaceans totals	7					4	2	2	1	16	10.46
Pseudechinus magallanicus								1		1	0.65
Loxechinus albus		1								1	0.65
Sea urchins totals		1						1		2	1.31
Salilota australis						1				1	0.65
Genypterus sp.	3									3	1.31
Cottoperca gobio			1							1	0.65
Fishes totals	3		1							4	2.61
Birds totals	1					1	2	4		8	5.23
Total	15	17	23	0	0	9	11	77	2	153	100.00

high percentage of feces with *Cancer edwardsi* (28.0%), a species only shared with sector II, but of only 2.56%. Furthermore, the sector exhibits a high percentage (52.0%) of feces containing *Acanthocyclus albatrossis*. Sector V (Uribe channel) is separated from the main group (similarity 0.55) by high consumption of *Grimothea gregaria* (100.0%) and sector IX (New Year Sound and Cap Horn) (similarity 0.65) with a high percentage of feces containing *Lithodes santolla* (33.3%), *Paralomis granulosa* (28.6%), and only *Patagonotothen* species among fish (19.05%).

Among the main group, two sectors can be recognized: VII and VIII (Xaultegua Gulf to Beagle Channel) (similarity 0.83), and sectors II-VI (Trinidad channel to Queen Adelaide archipelago) (similarity 0.83). Sector V (Uribe channel) is associated with the previous group, with a closure value of 0.70.

Regarding the consumption of fish/crustaceans by the huillín in Aysén and Magellanic channels (Fig. 4), no specific trend along the latitudinal gradient is evident. However, in the northern sector of the Aysén canals (sectors I-III), there is a more combined consumption of fish/crustaceans (both items in >80% of feces). In Aysén IV (San Rafael lagoon) and the Magellanic channels, the consumption shows to be more specific (one of both items in < 60% of feces)

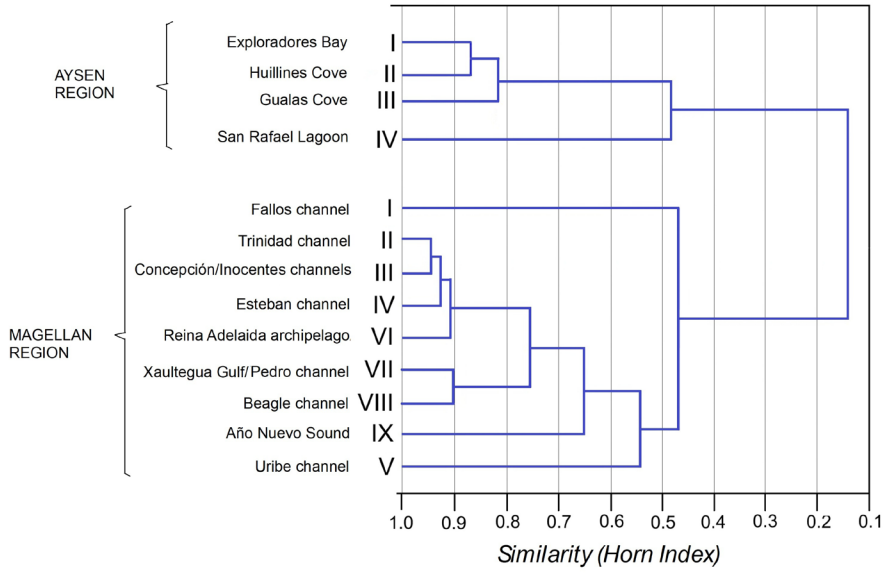


Fig. 4: Similarity analysis [Horn Index; paired group (UPGMA); cophenetic correlation 0.9205] between feces of huillin by sectors I-IV of the Aysén region and I-IX of the Magellanic region.

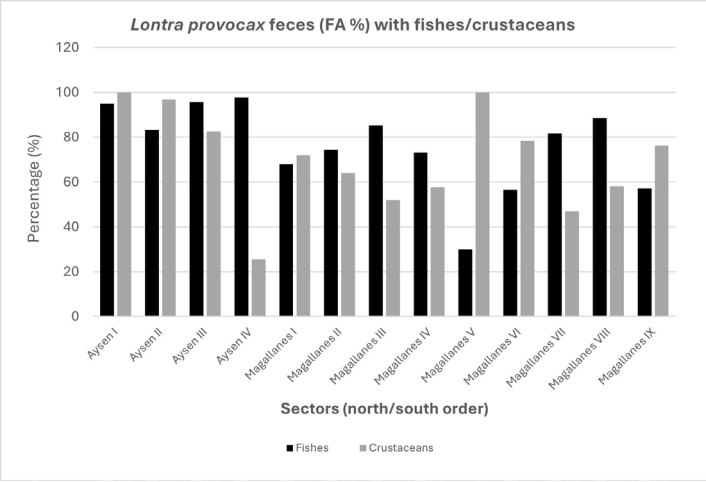


Fig. 5: Fecal composition (FA) of fish/crustaceans from the huillin in the latitudinal gradient in channels and fjords of Aysén and Magallanes.

(Fig.5; Tables 5 & 6).

Niche amplitudes (breath) (H'est) varied between 0.649 to 0.103. In the Northern sector of Magallanes values reach 0.524 at Fallos channel. South of the Magellan Straits niche amplitude is highest at Pedro channel (0.65). The mean breath can be considered as relatively high (mean 0.468; variance 0.0261) and indicates a diversified use of prey resources. Narrowing niche breath to 0.103 in Uribe channel, may be related to restrictions on food supply because of more adverse conditions for huillin due to the oceanic influence of the Nelson Strait. Levin's measure of niche breath shows lower values but following the same tendency as Shannon-Wiener measure (Fig. 6).

b.3. The chungungo in the Pacific coast of Peru and Chile

Reports on diet composition along the Pacific coast between southern Peru and Cape Horn (18°-56°S) based on fecal analyses (Table 10) mention 83 prey species, of which 35 are fishes, 31 crustaceans, 17 mollusks, and 2 echinoderms (For data sources see Table 1). In addition, 12 species of coastal birds (Table 11) and mollusks (*Plaxiphora*, *Concholepas*, *Odontocymbiola*, *Argobuccinum*, *Trophon*, *Acanthina*, and *Tegula*) were reported around latrines, trails, and dens (Table 11) and assumed to be consumed preferentially on land due to their larger size and shell shape (Table 12).

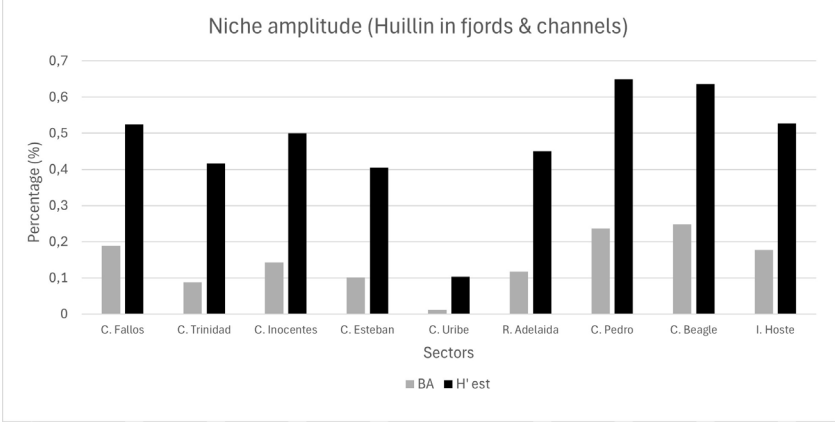


Fig. 6: Niche amplitude (BA = Standardized Levin's index; H'est = Standardized Shannon-Wiener index) of the huillin in fjords and channels of Magellanic Region.

The fecal composition according to latitude (Table 13) shows a consumption focused primarily on fish and crustaceans. In the records expressed as PA (appearance index) the percentage of feces with fish varied between 12.50% and 62.50% (mean = 38.58; sd. 13.599) and for crustaceans between 35.40 and 87.5% (mean = 60.61; sd. 13.822) (Table 10; Fig. 7).

Records expressed as FA (Frequency index) fishes varied between 22.0% and 86.57% (mean = 65.05; sd. 25.546) and for crustaceans between 22.2% and 86.57% (mean = 54.03; sd. 24.018).

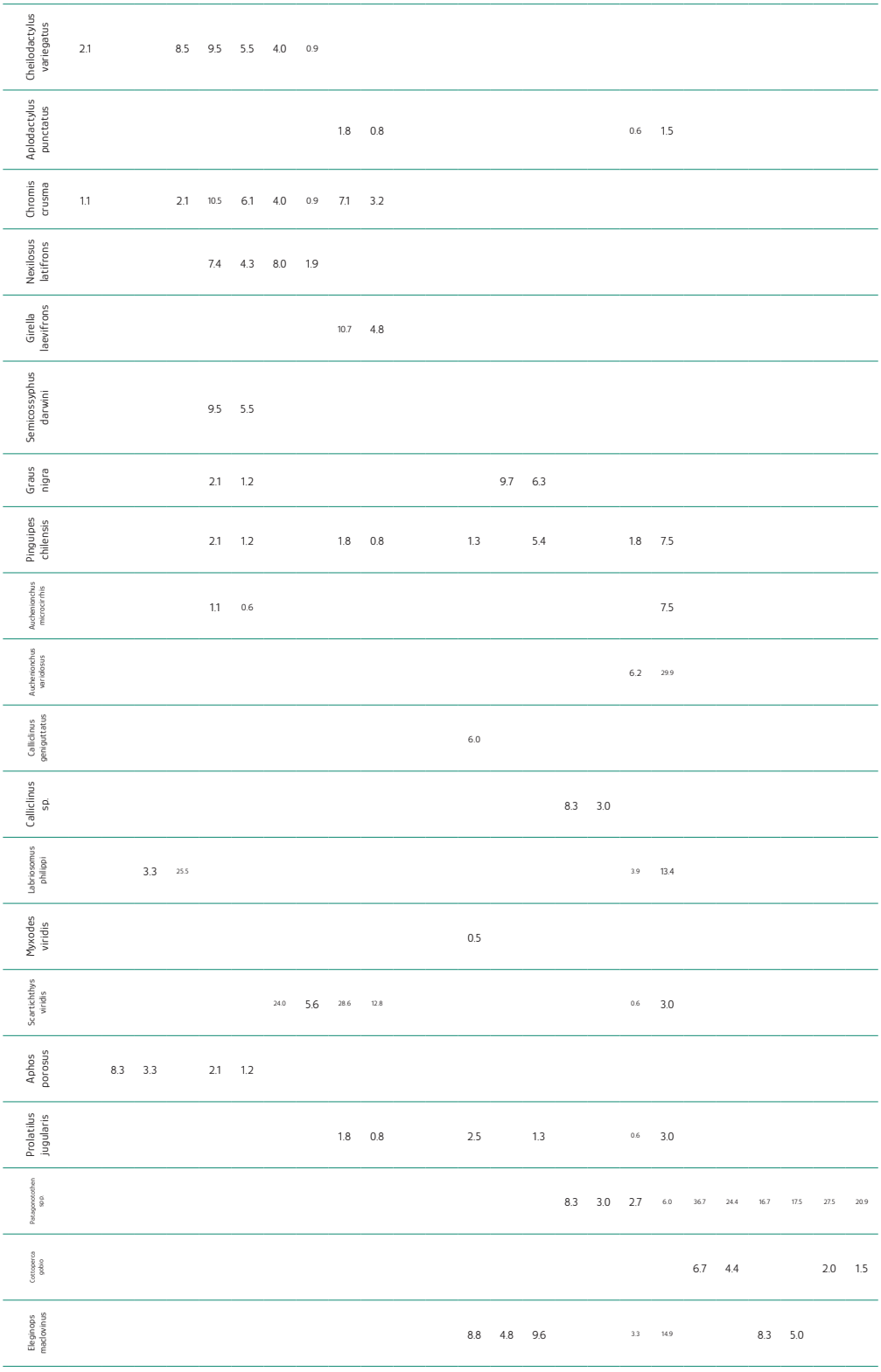
A comparison of FA values between sectors (Table 10) shows a higher percentage of feces containing fish (68.4%–71.2%) in the northernmost sector (18°03'S – 32°40'S) and 67.7%–88.9% of feces in the southern sector (42°10'S – 39°40'S). The intermediate zone (24°40'S – 39°40'S) presents values between 22.0%–62.3%, where the situation in Valdivia stands out with only 22.0% and Pan de Azucar with 38.7%. In both the northern and southern extremes, the percentage of feces containing fish exceeds the percentage of feces containing crustaceans. In the intermediate sector (Pan de Azucar, Isla Choros, Valdivia), the percentage of feces containing crustaceans exceeds that of fish.

Regarding fish, the prey size varies from north to south (Appendix: Table 1) ranging from medium to large in the Patache sector (20°45'S) (*Acanthistius*, *Cheilodactylus*, *Chromis*, *Nexilosus*, *Semicoscyphus*, *Graus*, *Pinguipes*, *Auchenionchus*) to small and medium in the Pan de Azúcar (24°40'S) and Isla Choros (29°16'S) sectors (*Cheilodactylus*, *Aplodactylus*, *Chromis*, *Nexilosus*, *Scartichthys*, *Prolatilus* and *Syciases*); in both cases *Scartichthys* is the most frequent.

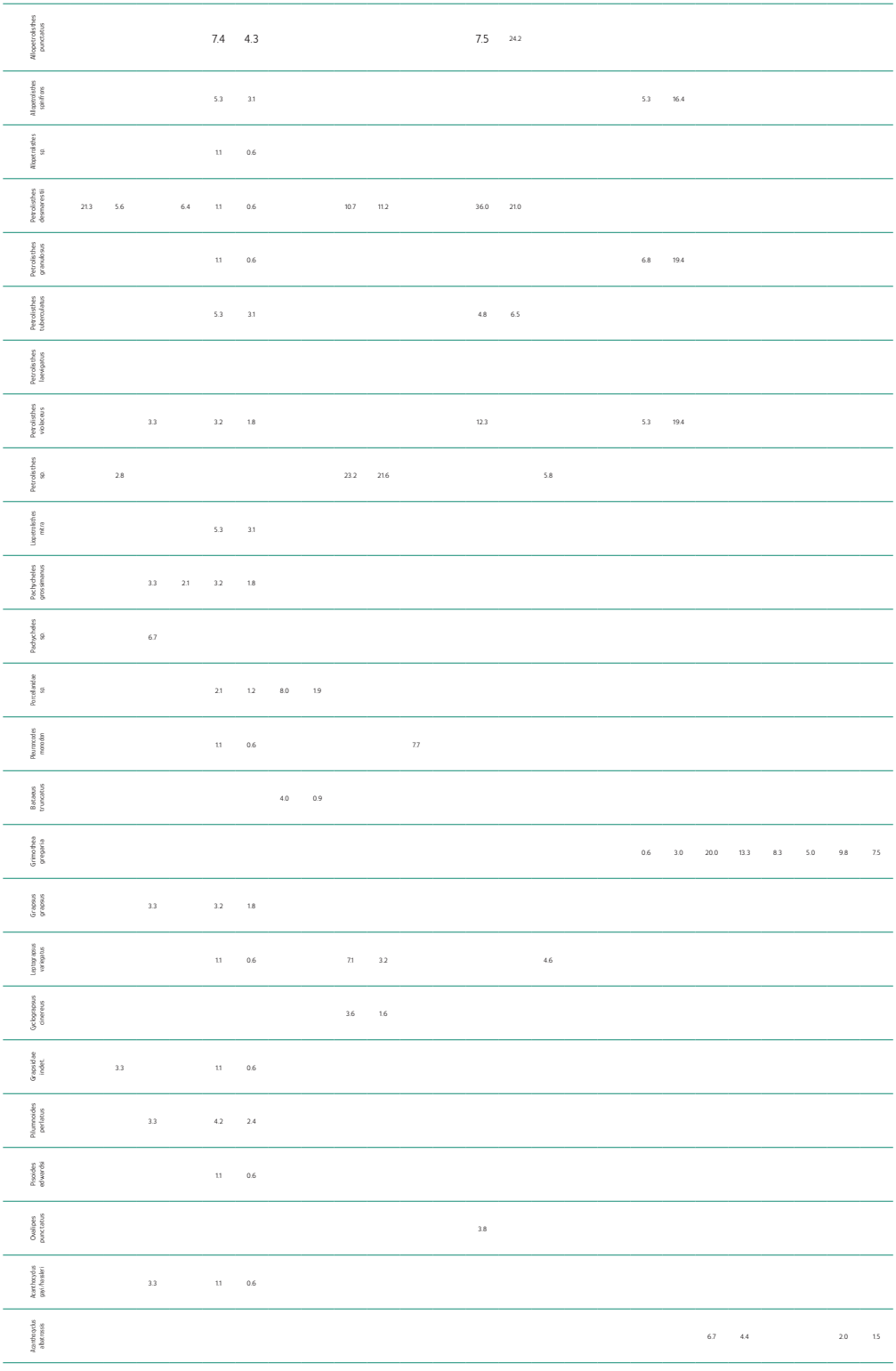
Information for southern Peru (Morro Sama, Vila-Vila, Quebrada Burros) has been presented in different ways (PA a/o FA) (Table 10), making comparison difficult. These studies report on *Sciaena deliciosa*, *Trachurus murphyi*, *Isacia conceptionis*, *Aphos porosus*, *Labrisomus*

Table 10: Composition of chungungo feces found along the rocky shore of the Southeastern Pacific Ocean. (a. Appearance index (PA) = percentage of total number of specimens of a prey species, calculated on the total number of prey specimens found; b. Frequency index of occurrence (FA) = percentage of feces with an item, calculated on the total number of feces (Data origin and reference is indicated in the table; (*): data of 1212 and 2013 are treated as a whole; n.d.=no data).

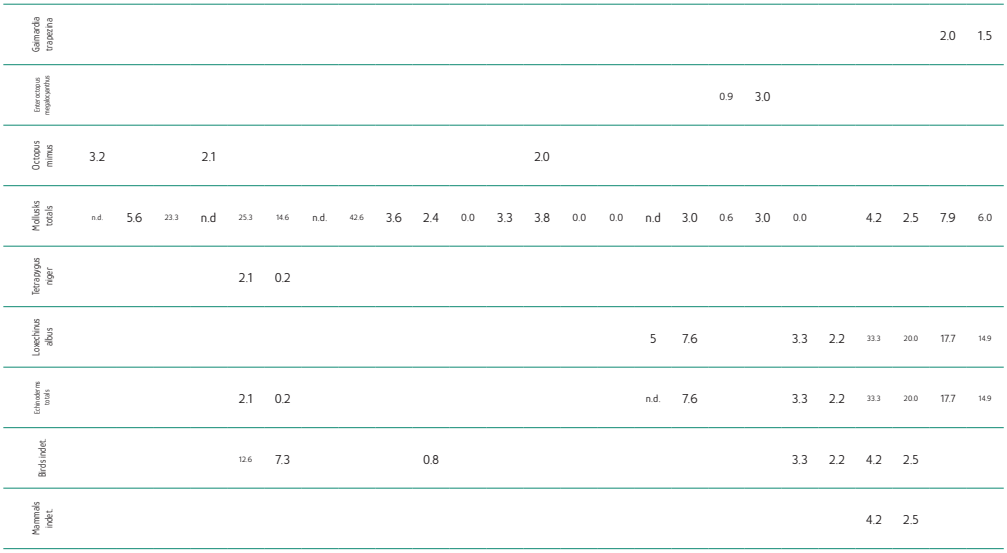
Sectors	Sama	Sama	Quebrada Burros	Vila-Vila	Patache	Patache	Pan de Azucar	Pan de Azucar	Isla Choros	Isla Choros	Cta. Chome	Sn. Vicente	Valdivia	Calfuco+Pilolcura	Pucatrihue	Chiloé	Chiloé	Isla Guafo (*)	Isla Guafo (*)	Stosch – Estr. Nelson	Stosch – Estr. Nelson	Skyring – I. Stewart	Skyring – I. Stewart	New Year S./Cap Horn	New Year S./Cap Horn
Latitude	17o 60' S	17o 60' S	18o 02' S	18°03'S	20°45'S	20°45'S	24°40'S	24°40'S	29°16'S	29°16'S	36°46'S	36°43'S	39°40'S	39°46'S	40°28'S	42°10'S	42°10'S	43°30'S	43°30'S	49°-53°S	49°-53°S	54°-55°S	54°-55°S	55°-56°S	55°-56°S
Data origin and references	Pizarro-Neira, 2014	Biffi & Iannacone, 2010	Biffi & Iannacone, 2010	Pizarro-Neira, 2014	New data	New data	Ostfeld *et al.*, 1989	Ostfeld *et al.*, 1989	Villegas, 2002	Villegas, 2002	Poblete *et al.* 2019	Poblete *et al.*, 2019	Medina *et al.*, 2004	Solari, 2024	Córdova *et al.*, 2009	Ostfeld *et al.*, 1989	Ostfeld *et al.*, 1989	Núñez, 2014	Núñez, 2014	Sielfeld, 1980 1989	Sielfeld, 1980 1989	Sielfeld, 1980 1989	Sielfeld, 1980 1989	Sielfeld, 1980 1989	Sielfeld, 1980 1989
Index type	PA	FA	FA	PA	FA	PA	FA	PA	FA	PA	PA	PA	FA	PA	PA PA	FA	PA	PA	FA	FA	PA	FA	PA	FA	PA
Sample size (number of feces)	-	36	30	-	95	95	25	25	56	56	65	66	475	29	106	24	24	67	67	30	30	24	24	51	51
Engraulis ringens					3.2	1.8																			
Acanthistius pictus	4.3			4.1	5.2	3.1																			


Cheilodactylus variegatus
2.1 8.5 9.5 5.5 4.0 0.9
Aplodactylus punctatus
1.8 0.8 0.6 1.5
Chromis crusma
1.1 2.1 10.5 6.1 4.0 0.9 7.1 3.2
Nexilosus latifrons
7.4 4.3 8.0 1.9
Girella laevifrons
10.7 4.8
Semicossyphus darwini
9.5 5.5
Graus nigra
2.1 1.2 9.7 6.3
Pinguipes chilensis
2.1 1.2 1.8 0.8 1.3 5.4 1.8 7.5
Auchenionchus microcirrhis
1.1 0.6 7.5
Auchenionchus variolosus
6.2 29.9
Calliclinus geniguttatus
6.0
Calliclinus sp.
8.3 3.0
Labrisomus philippi
3.3 25.5 3.9 13.4
Myxodes viridis
0.5
Scartichthys viridis
24.0 5.6 28.6 12.8 0.6 3.0
Aphos porosus
8.3 3.3 2.1 1.2
Prolatilus jugularis
1.8 0.8 2.5 1.3 0.6 3.0
Patagonotothen spp.
8.3 3.0 2.7 6.0 36.7 24.4 16.7 17.5 27.5 20.9
Cottoperca gobio
6.7 4.4 2.0 1.5
Eleginops maclovinus
8.8 4.8 9.6 3.3 14.9 8.3 5.0

Bovichthys chilensis													5.8		3.3			4.2	17.91						
Harpagifer bispinnis																						4.2	2.5		
Trachurus murphyi		2.8																							
Merluccius gayi															3.3										
Cilus gilberti															1.7										
Sebastes capensis															0.4										
Clupeidae indet.																4.2	1.5								
Sicyases sanguineus							12.0	2.8						3.2	1.7			1.8	6.0						
Gobiesocidae													4.5		3.3										
Sciaena deliciosa		2.8		2.1																					
Isacia conceptionis	2.1								3.6	1.6								0.3	1.5						
Stromateus stellatus																		0.6	3.0						
Genypterus chilensis													1.3	6.5	2.9										
Paralichthys microps													0.5	1.6				0.6	1.49						
Odontesthes regia													0.3												
Pisces indet.	34.0	5.6	3.3	16.3	27.4	15.9	36.0	10.2	78.6		12.5	20.9	22.0	19.4		37.5	13.6		23.9	43.3	28.9	37.5	22.5	51.0	38.8
Fishes totals	n.d.	19.5	9.9	n.d.	68.4	46.3	n.d	22.2	78.6	24.8	12.5	20.9	22.0	45.2	39.2	n.d.	21.2	37.4	91.0	86.7	57.8	66.7	47.5	80.4	61.2
Rhynchocinetes typus	12.8				1.1	0.6	48.0	21.3																	
Campylonotus vagans																				3.3	2.2	29.2	17.5	7.8	6.0
Allopetrolisthes angulosus		1.5	2.8		7.4	4.3																			


Allopetrolisthes punctatus
7.4 4.3 7.5 24.2
Austrolisthes spinifrons
5.3 3.1 5.3 16.4
Austrolisthes sp.
1.1 0.6
Petrolisthes desmarestii
21.3 5.6 6.4 1.1 0.6 10.7 11.2 36.0 21.0
Petrolisthes granulosus
1.1 0.6 6.8 19.4
Petrolisthes tuberculatus
5.3 3.1 4.8 6.5
Petrolisthes laevigatus
Petrolisthes violaceus
3.3 3.2 1.8 12.3 5.3 19.4
Petrolisthes sp.
2.8 23.2 21.6 5.8
Lauroltolisthes mitra
5.3 3.1
Pachycheles grossimanus
3.3 2.1 3.2 1.8
Pachycheles sp.
6.7
Porcellanella sp.
2.1 1.2 8.0 1.9
Pleuroncodes monodon
1.1 0.6 7.7
Balanus truncatus
4.0 0.9
Grimothea gregaria
0.6 3.0 20.0 13.3 8.3 5.0 9.8 7.5
Grapsus grapsus
3.3 3.2 1.8
Leptograpsus variegatus
1.1 0.6 7.1 3.2 4.6
Cyclograpsus cinereus
3.6 1.6
Grapsidae indet.
3.3 1.1 0.6
Plumnoides perlatus
3.3 4.2 2.4
Pisoides edwardsi
1.1 0.6
Ovalipes punctatus
3.8
Acanthodactylus gayi/kovalevi
3.3 1.1 0.6
Acanthocyclus albatrossis
6.7 4.4 2.0 1.5

Cancer coronatus																	3.0																		
Cancer edwardsii																	33.0			2.1							13.3		8.9						
Cancer setosus	17.0				23.4				24.0	5.6	33.9	15.2	56.7	63.7	1.8			11.3	41.7	15.2															
Homalaspis plana											12.5	5.6	3.9		12.8			11.7	8.3	3.0															
Paraxanthus barbiger											1.8	0.8			14.3			7.1			1.8	6.0											
Platyxanthus orbignyi	1.1				4.1																													
Taliepus dentatus											30.4	13.6	19.2	12.1	58.0			18.3	41.7	15.2	36.2	74.6	13.3	8.9									
Lithodes santolla																							3.3	2.2	4.2	2.5	3.9	3.0					
Crustacea indet.					2.1				24.0	5.6	16.1	18.8			18.5	3.2			41.7	15.2	5.9	20.9											
Crustaceans totals	n.d.	13.2	26.0	n.d	56.8	32.3	n.d.	35.2	91.1	72.8	87.5	75.8	78.4	54.8	60.8	n.d	48.5	62.0	86.6	66.7	40.0	45.8	25.0	23.5	17.9								
Scurria viridula		5.6	13.3																														
Chiton cummings											1.8	0.8																					
Chiton sp.																			8.3	3.0							2.0	1.5					
Tegula sp.											1.8	1.6																					
Lurifictorina galgnea																									4.2	2.5							
Calyptella sp.									4.0	0.9																	2.0	1.5					
Concholepas concholepas																			4.1	1.5													
Eatonum sp.									4.0																		2.0	1.5					
Crepipatella dilatata			3.3																														
Fissurella crassa					1.1	0.6																											
Fissurella peruviana					10.5	6.1																											
Fissurella maxima					3.2	1.8																											
Fissurella picta																			4.1	1.5													
Fissurella latimarginata					1.1	0.6																											
Fissurella sp.															1.5																		
Semimytilus algosus			6.7						12.0	40.7				3.30																			



Sectors	Patache	Isla Choros	Valdivia (*)	Stosch – Estrecho Nelson	Skyring – Isla Stewart	S. Año Nuevo – Cap Horn
Latitude	20°45'S	29°16'S	39°40'S	49°00'-52°30'S	54°30-55°00'S	55°00'-56°00'S
Acanthistius pictus	3					
Trachurus murphyi				1		1
Paralabrax humeralis	1					
Pisces indet.				2		3
Fishes						
Petrolisthes desmarestii		7				
Petrolisthes sp.		16				
Pachycheles grossimanus	8					
Leptograpsus variegatus		2				
Ovalipes punctatus			1.8			
Cancer coronatus			3.4			
Cancer edwardsii			25.8	3		
Cancer setosus		62	8.1			

Table 11: Species, number and size of chungungo food remains found around trails, latrines and denning sites of chungungo at the rocky shore of the Southeastern Pacific Ocean [Sources: Patache (Sielfeld, new data); Isla Choros (Villegas, 2002); Valdivia (Medina, 1995; Medina *et al.*, 2004); Magallanes: I. Stosch-Estrecho Nelson, I. Skyring-I. Stewart, Seno Año Nuevo-Archipiélago del Cabo de Hornos (Sielfeld, 1984, 2006); *: expressed as % by Medina et al., 2004].

Homalaspis plana	23	22.1			
Paraxanthus barbiger	7	18.4			
Taliepus dentatus	57	20.1	2		
Lithodes Santolla					3
Paralomis granulosa				1	
Crustaceans	174				
Scurria scurra					1
Nacella magellanica					10
Chiton cummings	2				
Plaxiphora aurata			1		3
Tegula atra	16		1		
Argobuccinum magellanicus			1		4
Trophon geversianus					1
Acanthina monodon					1
Odontocymbiola magellanica					2
Concholepas concholepas			6		
Fisurella cummingi	13				
Fisurella picta			9	10	
Fisurella nigra			1		
Fisurella oriens				1	
Mollusks	31				
Loxechinus albus			4	8	
Echinodermos totals					
Chloephaga hybrida					1
Tachyeres pteneres			1		
Lophonetta specularioides					1
Larus dominicanus			1		
Leucophaeus skoresbii					1
Sterna hirundinacea					1
Nycticorax nycticorax					1
Milvago chimango			1		
Leucocarbo magellanicus				1	2
Leucocarbo atriceps					1
Phalacroracidae indet.					2
Pelecanoides garnotti	7				
Aves totals					

Site	Species	N	Anatomical parts
Islas Beauclerk	*Tachyeres pteneres*	1	Sternum, adult
	Fisurella picta	1	Shell length 69 mm
	Loxechinus albus	3	Diameters 66; 86; 91 mm
	Osteichthyes indet.	1	Jaw fragment
Isla Stewart	*Loxechinus albus*	7	Diameters 72; 91; 84; 83; 74; 78; 73 mm
	Paralomis granulosa	1	chela; immesurable
	Fisurella picta	3	Shell length 52; 59; 79 mm
Isla Skyring	*Loxechinus albus*	3	Diameters 67; 71; 54 mm
	Fisurella picta	7	Shell length 68; 59; 58; 42; 46; 57; 71 mm
Bahía India	*Fisurella picta*	2	Shell length 85; 90 mm
	Plaxiphora aurata	1	Length 72 mm
	Argobuccinum magellanicum	1	Length 93 mm
	Osteichthyes indet.	2	Vertebrae; immesurable
	Lithodes santolla	2	Cephalothorax 1, length 52 mm; cefalothorax 2, fragment
	Chloephaga hybrida	1	Sternum, adult
	Phalacrocorax magellanicus	2	Sternum. adult; part of a jaw
	Phalacrocorax sp.	1	Synsacrum; adulto
Seno Cráter	*Fisurella picta*	1	Shell length 75 mm
	Phalacrocorax sp.	1	Skull, adult
Orella: Isla Stosch	*Fisurella picta*	4	Shell length 87; 75; 77; 49 mm
	Fisurella nigra	1	Shell length 85 mm
	Tegula atra	1	Length 50 mm
	Cancer edwardsii	3	Cephalothorax, incomplete; chelae
	Plaxiphora aurata	1	Plates, incomplete; immesurable
	*Argobuccinum magellanicu*m	1	Length 72 mm
	Larus dominicanus	1	Breast skin and feathers
	Concholepas concholepas	5	Shell length 98; 57; 54; 63; 83 mm
	Loxechinus albus	1	Diameter 50 mm
	Milvago chimango	1	Skull; adult
	Taliepus dentatus	1	Cephalothorax, incomplete; immesurable
Puerto Alert	*Trachurus symetricus*	1	Adult skull
Isla Contreras	*Cottoperca gobio*	1	Head and pectoral fins
Isla Grevy	*Nycticorax nycticorax*	2	Vertebrae, synsacrum, clavicicle, humerus
	Argobuccinum magellanicum	3	Length 65; 83; 92 mm
	Plaxiphora aurata	2	Length 85; 90 mm
	Trachurus symetricus	1	Skull; adult

Table 12: Species, number and size of chungungo food remains found around trails, latrines and denning sites of fjords, channels and sounds of the Magallan region (Source: Sielfeld, 1984, 1989)

	Phalacrocorax indet.	2	1 phalanx bone, 2 metatarsals, juvenil; jaw, adult
	Loxechinus albus	11	Diameters 79; 86;105; 95; 81; 90; 94; 95; 74; 100; 85 mm
	Fisurella picta	18	Shell length 72; 78; 57; 60; 81; 90; 94; 87; 88; 57; 90; 83; 74, mm
	Odontocymbiola magellanica	2	Length 174; 175 mm
	Phalacrocorax magellanicus	1	Sternum and left humerus; juvenil
	Nacella magellanica.	10	Shell length 54; 54; 57; 61; 64; 65; 62; 29; 31; 47 mm
	Scurria scurra	1	Shell length 33 mm
	Osteichthyes indet.	1	Vertebrae and opercular bones; immesurable
	Trophon geversianum	1	Length 35 mm
	Sterna hirundinacea	1	Sternum, coracoides, clavicles and femora
	Lophonetta specularioides	1	Left femur izquierdo, ulna and radius; skin and feathers
	Larus scoresbii	1	Sternum, clavícle, coracoides and festhers
	Acanthina monodon	1	Length 65 mm
	Lithodes santolla	1	Parto f Cephalothorax; immesurable
TOTAL		123	

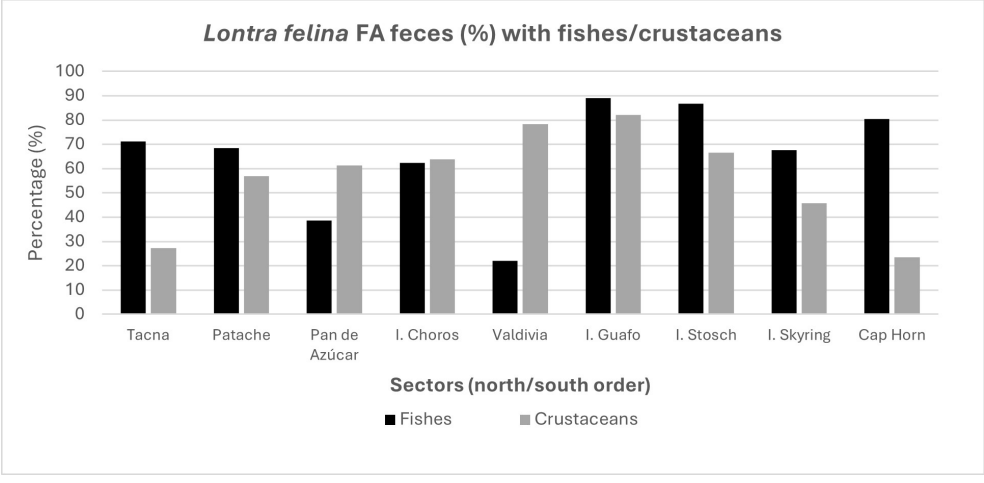


Fig. 7: Fish/crustacean FA fecal composition (%) of chungungo in the latitudinal gradient.

philippi, *Chromis crusma*, *Cheilodactylus variegatus* and *Acanthistius pictus*.

The feces from Central Chile between Pan de Azúcar and Pucatrihue (24°40'S-40°28'S) do not include serranids and wrasses. Reported fishes are *Cheilodactylus*, *Aplodactylus*, *Chromis*, *Nexilosus*, *Girella*, *Genypterus*, *Prolatilus*, *Pinguipes*, *Eleginops*, *Bovichtus*, *Sicyases*, *Paralichthys*, *Calliclinus*, *Myxodes*, *Scartichthys*). In this group, the percentage of feces containing fish is lower than the percentage containing crustaceans, especially in Valdivia (22%).

In the Chiloé (42°10'S) and Guafo Island (43°30'S) sectors, the feces show the presence of typical fish of the central Chilean coast (*Aplodactylus*, *Auchenionchus*, *Calliclinus*, *Scartichthys*, *Prolatilus*, *Bovichtus*, *Sicyases*, *Isacia*, *Pinguipes*, *Paralichtys*) together with species of southern distribution (*Patagonotothen*, *Eleginops*).

In the southern zone, south of the Taitao Peninsula (49°-56°S), consumption is focused on *Cottoperca*, *Eleginops*, and *Harpagifer*, but primarily species of the genus *Patagonotothen* (17-37% of feces) (Table 10).

Crustacean consumption in the northern zone (18°S-24°40'S) consisted primarily of small porcellanid crustaceans (*Petrolisthes*, *Allopetrolistes*, and *Liopetrolistes*). *Pachycheles* were recorded only in feces from Tacna and Patache. Porcellanids were found in up to 10 species in Patache. *Pilumnoides* (Family Pilumnoididae) were also restricted to this sector. *Rhynchocinetes typus* was recorded from Patache (20°45'S) as far south as Pan de Azúcar (24°40'S) (Table 10) being particularly important, reaching up to 48% FA in this last locality.

Grapsids (*Grapsus*, *Leptograpsus*, *Cyclograpsus*) were recorded from Tacna to Choros Island (18°03'S–29°16'S). Munids were represented by *Pleuroncodes monodon* in the Patache area and *Grimothea gregaria/subrugosa* in feces from Guafo Island southward, being especially prominent in the northern sector of Magallanes (49°00'S–52°30'S). A*canthocyclus* (Bellidae) was present in feces from Tacna and Patache (*A. gayi/hassleri*) and Magallanes (*A. albatrossis*). In Epialtidae, *Pisoides edwardsi* was found in Patache and *Taliepus* in sectors of central Chile from Choros Island to Nelson Strait (29°16'S–52°30'S). *Homalaspis* (Platyxanthidae) was detected between Choros Island and Chiloé and *Paraxanthus* (Xanthidae) between Choros Island and Guafo Island, both species mainly important in Valdivia (FA 12.8% and 14.3% of feces respectively) and Choros Island (FA 12.5% and 1.8% of feces respectively).

In Cancridae three species are reported in feces: *Cancer setosus* between southern Peru and Chiloé, reaching FA of 24.0% and 41.67% of feces respectively, Isla Choros FA 33.9% of feces and Pan de Azucar and Chiloé FA 24.0%. For Chome and San Vicente only PA values are available with 56.7% and 63.7% respectively. *Cancer edwardsi* was found in feces of Valdivia (FA 33.0%), Pucatrihue (2.1%) and Estrecho Nelson in the northern part of Magallanes (FA 13.3% of feces); *Cancer coronatus* and *Ovalipes punctatus* (Ovalipidae) were only reported in feces from Valdivia (FA 3.0% and 3.8% of feces, respectively) (Table 10).

The food remains reported for southern Chile (Table 11) were mainly *Fisurella picta* (20.2% of the remains), *Loxechinus albus* (12.8%), *Nacella magallanica* (10.6%), *Concholepas concholepas* (6.4%), and *Argobuccinum magellanicus* (5.3%). The remains of 24 other species did not exceed 4% of the total recorded specimens.

Taliepus dentatus is an important food item from Isla Choros to Estrecho Nelson with

important FA values in Isla Choros (30.4%), Valdivia (58.0%), Pucatrihue (18.3%), Chiloé (41.7%) and Isla Guafo)74.6%) (Table 10).

Regarding mollusk consumption, these are mostly small (*Laevilittorina*, *Colisella*, *Epitonium*, *Crepipatella*, *Gaimardia*), probably ingested unintentionally or as part of the stomach contents of some rock fish. Because of is bigger size (50-100 mm shell length) four species of *Fisurella* (*F. picta*, *F. nigra*, *F. oriens*) found around latrines and trails in Magallanes, *F. cummingi* in Punta Patache and smaller specimens (< 15 mm shell length) of *F. crassa*, *F. peruviana*, *F. maxima* and *F. latimarginata* in feces from Punta Panache were considered as part of the diet. Other larger mollusks associated with trails and feeding places south of 40°S in Magallanes were *Concholepas concholepas* (49°00'S-52°30'S), and in the southern sector of Magallanes (55°-56°S), gastropods of the genera *Odontocymbiola*, *Acanthina*, *Trophon*, and *Argobuccinum* (Table 12).

The composition of food remains associated with feeding places, trails and latrines varied significantly along the latitudinal gradient (Table 13). Thus, for the Tarapacá: Patache region, only rockfishes (*Acanthistius pictus* and *Paralabrax humeralis*) and the crustacean *Pachycheles grossimanus* were recorded. For central Chile (Choros Island and Valdivia), reported remains consisted of porcellanid crustaceans, grapsids, cancrids, epialtids, and gastropods (*Fisurella cummingi*, *Tegula atra*, and *Chiton cummingsi*). Birds were only represented by a juvenile *Pelecanoides garnotti*.

The niche overlap between sectors along the latitudinal gradient (20°-56°S) (Fig. 8) shows low similarity values between sectors, which determine local feeding patterns, probably because of different prey availability in each zone. Within this framework, three large groups can be identified: the Magellanic zone (49°-55°S), the central Chilean zone (29°-43°S), and the extreme north of Chile and Peru (18°-20°S). Special mention should be made of the Pan de Azúcar Island sector (24°- 40°S), with which brings together intermediate characteristics between northern and central Chilean sectors.

In Fig. 8, the situation of southern Peru (Morro Sama, Vila-Vila, quebrada Burros) deserve special consideration. Their low similarity (<0.1) with other sites is probably result of human influence and alteration in food supply for otters due to the artisanal fishing activity that characterizes that sector. A similar situation may also explain the low similarity of Caleta Chrome and Bahía San Vicente in Chile.

The niche breath in the chungungo (H'est and B A) coincide in indicating that most sectors have restricted diets, with meaning H'est = 0.45; variance 0.0141 (Fig. 9). Outstanding outliers are Pucatrihue (H'est = 0.89) and Punta Patache (H'est = 0.67), with a high niche breadth relative to the others. This indicates a more balanced and diversified use of prey as a generalist. Little anthropogenic intervention allows an intertidal/subtidal zone with abundance and diversity of porcellaniids, which explains their importance in the diet of the sector.

The Morro Sama, Pan de Azúcar, Cta. Chome, and San Vicente sectors have very low niche

Sector	Reference	Latitude (S)	Fishes	Crustaceans	Mollusks	Equinoderms	Others
Morro Sama	Mangel *et al.* (2011) (***)	17°52′	40.60	43.10			
Morro Sama	Pizarro (2014) (*)	17°60′	49.0	48.0	2.94		
Morro Sama	Biffi & Iannacone (2010) (**)	17°60′	61.10	22.20	2.77		13.89
Quebrada Burros	Biffi & Iannacone (2010) (**)	18°02′	83.33	33.33	6.67		
Vila Vila	Mangel *et al.* (2011) (***)	18°03′	48.20	21.70	0.00	0.50	29.20
Vila Vila	Pizarro (2014) (*)	18°03′	62.50	35.42	2.08		
Patache	Este trabajo (**)	20°45′	68.42	56.84			
Pan de Azúcar	Ostfeld *et al.* (1984) (*)	24°40′	38.70	61.30			
Pan de Azúcar	Ostfeld *et al.* (1984) (*)	24°40′					
Punta Cachos	Solari (2024) (*)	27°39′	≈ 44.0	≈ 56.0			
Isla Choros	Villegas (2002) (*)	29°16′	78.60	91.10	3.60		
Isla Choros	Villegas (2002) (**)	29°16′	24.80	72.89	2.40		0.80
Cta. El Arrayan	Solari (2024) (*)	29°41′	≈ 40.0	≈ 60.00			
Totoralillo	Solari (2024) (*)	30°04′	≈ 31.0	≈ 69.00			
San Vicente	Poblete *et al.* (2019) (*)	36°43	20.88	75.82	3.30		
Cta. Chome	Poblete *et al.* (2019) (*)	36o 46	12.50	87.50			
Valdivia	Medina *et al.* (2004) (**)	39°40′	22.00	78.40	3.75		
Pilolcura	Solari (2024) (*)	39°40′	40.90	59.10			
Calfuco	Solari (2024) (*)	39°46′	47.50	52.50			
Chiloe	Ostfeld *et al.* (1984) (*)	42°10′	21.21	48.48	3.03		
Isla Guafo	Núñez (2014) (*)	43°30′	37.39	62.02	0.59		
Isla Guafo	Núñez (2014) (**)	43°30′	91.04	86.57	2.99		
Isla Stosch	Sielfeld (1984, 2006) (**)	49° -53°	86.70	66.67			
Isla Skyring	Sielfeld (1984, 2006) (**)	54°-55°	67.71	45.83	4.17		
Cap Horn	Sielfeld (1984, 2006) (**)	55°-56°	80.39	23.53	7.84		

Table 13: Comparative composition (%) of fish, crustaceans, and mollusks in chungungo scats. [(*): Percentage of each species in the total prey specimens found in the scats; (**): Frequency of occurrence, equal to the number of scats in which a prey species appears, divided by the total number of scats, expressed as a percentage; (***): The percentage of each species in relation to the total captures observed through direct observation.

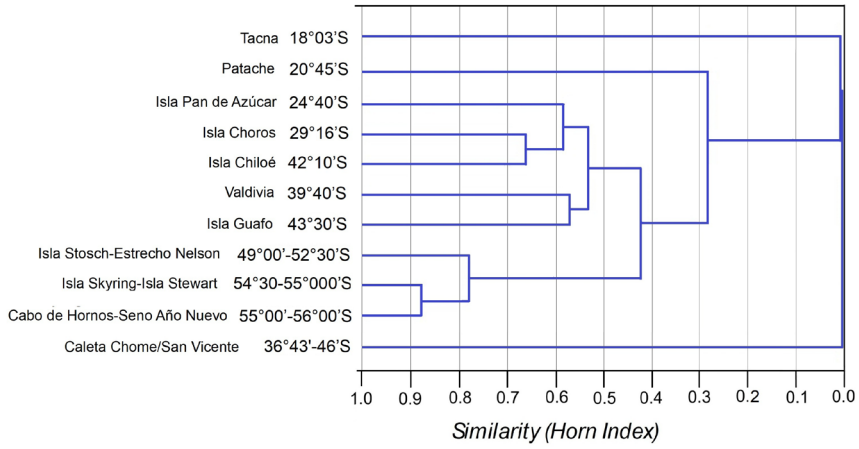


Fig. 8: Similarity analysis [Horn's Index; paired group (UPGMA); cophenetic correlation 0.9133] of the composition of chungungo feces by sectors.

breadths (H'est ≤0.40; B ≤0.04), indicating a greater degree of specialization with a strong dependence on a few dominant prey species. In this regard, these sectors are characterized by a high degree of anthropogenic intervention (pollution, fishing, shellfish extraction, macroalgae, anthropogenic modification of the coastal edge, etc.), which leads to higher diversity and availability of prey for the chungungo.

b. Prey size

b.1. Chungungo

At Punta Patache, the consumed fish were *Acanthistius pictus*, *Cheilodactylus variegatus*, *Chromis crusma*, *Nexilosus latifrons*, *Semicoscyphus darwini*, *Graus nigra*, *Pinguipes chilensis*, and *Auchenionchus* sp., identified by their scales and some bone pieces, corresponding to medium-

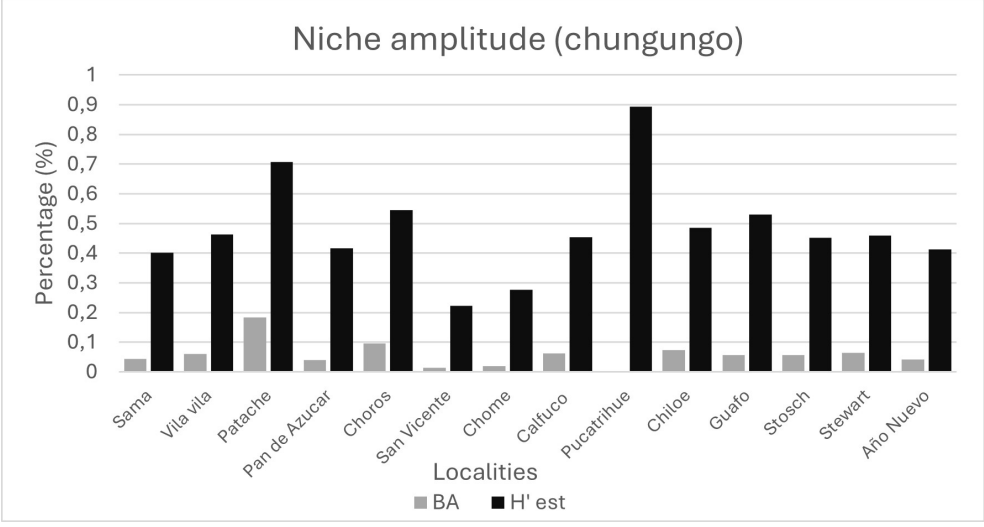


Fig. 9: Niche amplitude (BA = Standardized Levin's index; H'est = Standardized Shannon-Wiener index) of the chungungo along the Southeast Pacific coast between Southern Perú and Magellan Region.

sized individuals (15-25 cm T.l.; Appendix, Table 1). Their consumption is frequently carried out on land, leaving the head and part of the vertebral skeleton behind, which explains the absence of otoliths in the feces and the difficulty in estimating their size. Additionally, the consumption of blennies (*Scartichthys* sp.) was recorded on two occasions (pers. obs.) which, due to their smaller size, were ingested directly from the water. Figs. 7 and 8 show some of these cases.

In Pan de Azúcar (24°40'S), Choros Island (29°16'S) and Valdivia (24°40'S-39°40'S) predation is focused on species of medium to small size (Appendix, Table 1): *Cheilodactylus variegatus*, *Aplodactylus puntatus*, *Chromis crusma*, *Girella laevifrons*, *Nexilosus latifrons*, *Scartichthys* spp., *Prolatilus jugularis*, *Pinguipes chilensis*, *Bovichtus chilensis*, *Calliclinus* spp., *Myxodes* spp. and *Sicyases sanguineus*. The corresponding authors (Ostfeld *et al*., 1986; Villegas *et al*., 2002; Medina *et al*., 2004) do not indicate the corresponding prey size, but a size around ≤ 20 cm S.l. seems reasonable for these species. The spectrum also includes *Genypterus* sp. and *Paralichthys microps*, species that can reach larger sizes (see photograph). (≥ 20 cm).

Eleginops maclovinus, found in feces from Pucatrihue (40°28'S), Chiloé (42°10'S), Guafo island (43°30'S) and different sites south of Taitao peninsula (49°-56°S) can over 50 cm T.l. Fecal samples of Magallanes showed a prey mean size of 90.5 mm (range 59.5-14.6 mm T.l.) as was inferred from otolith length (Sielfeld, new data).

For the same region prey size of *Patagonotothen* spp. was estimated to be 82.2 mm (range 39.7-184.2 mm) and *Harpagifer bispinnis* 5.4 cm T.l.

Crustacean consumption by chungungo in the northern zone (18°S-24°40'S) centers principally on porcellanid crustaceans of the genera *Petrolisthes*, *Allopetrolisth*es, *Liopetrolisthes*, *Pachycheles* (C.l. up to 27 mm), *Pilumnoides* sp., family Pilumnoididae (C.w. up to 40 mm).

The grapsids found in feces between Tacna and Choros island (18°03'S–29°16'S) include the medium size crabs *Grapsus grapsus* (C.l. 77 mm), *Leptograpsus variegatus* (C.l. up to 15–55 mm), and *Cyclograpsus cinereus* (C.l. 16–17 mm). *L. variegatus* was also registered in Pucatrihue (40°28'S). The munid *Pleuroncodes monodon* (C.l. 12.2–23.3 mm; mean = 19.22 mm) was only registered in Panache (20°45'S). *Acanthocyclus gayi/hassleri* (Bellidae) from Tacna and Patache, and *A. albatrossis* from Magellan reach C.l. 19–22 mm. *Pisodes edwardsi* (Epialtidae) from Patache, and *Taliepus dentatus* (Majidae) reach C.l. 11–12 mm. *Homalaspis plana* (Platyxanthidae) and *Paraxanthus barbiger* (Xanthidae) from Choros island and Guafo island are robust crabs (130 mm and 70 mm C.w. respectively) normally consumed on land.

In Magellanic channels and fjords preyed crustaceans are the medium sized species *Campilonotus vagans* (C.l. 73-75 mm), *Grimothea gregaria/subrugosa* (C.l. 27-39 mm), and heavier and bigger *Taliepus dentatus* (120 mm C.l.), *Lithodes santolla* (120 mm C.l.) and *Paralomis granulosa* (115 cm C.l.).

Regarding mollusk consumption, these are mostly small species (*Laevilittorina*, *Colisella*, *Epitonium*, *Crepipatella*, *Gaimardia*) and most likely part of the stomach contents of other prey. Directly depreyed species are *Fisurella picta* (42–91 mm; mean = 72.05 mm) and *F. nigra* (85 mm), recorded as remains associated with feeding grounds in Magallanes, remains of *F. cummingi* at Punta Patache, and *F. crassa*, *F. peruviana*, *F. maxima*, and *F. latimarginata* in feces from the same site, all small specimens (< 15 mm shell length).

Other larger mollusks associated with denning sites and trails south of 40°S in Magallanes were *Concholepas concholepas* (49°00'S-52°30'S) (54-83 mm; average 70 mm), and in the southern sector of Magallanes (55°-56°S) *Odontocymbiola magallanica* (180 mm), *Acanthina monodon* (50 mm), *Trophon geversianus* (140 mm), and *Argobuccinum magellanicus* (65-92 mm) (Tables 11, 12).

Consumption of *Tetrapygus niger* sea urchin was only reported for Punta Patache due to spines in the fecal contents. The possibility that they may have been derived from the stomach contents of one of the larger fish preyed upon by the chungungo in that sector cannot be ruled out. The consumption of *Loxechinus albus* in Magallanes is demonstrated by the presence of spines in the feces (Table 10) and numerous skeletons associated with latrines, trails, and dens (Table 12), ranging in diameter from 50 to 105 mm (mean 80.4 mm; sd = 13.43; n = 24).

Carcasses of shore birds found around denning sites and trails of chungungo of the Magellan region were all adult specimens due to size and skeleton ossification. For central Chile depredation on a juvenile of the breeding colony of *Pelecanoides garnoti* from Choros Island was also reported (Table 11).

b.2. Huillin in fjords and channels

In fjords and channels of Magallanes, prey were predominantly juvenile *Patagonotothen* (S.l. inferred from otolith lengths in feces, ranged S.l.= 3.1–17.3 cm; mean 8.28 cm, S.d. = 2.75), *Eleginops maclovinus* (S.l. = 6.0–31.8 cm; mean 11.7 cm; S.l.= 10.1 cm), and *Sprattus fuegensis* (S.l. = 8.2–13.5 cm; mean 12.1 cm; sd. = 1.4 cm) (new original data).

Fig. 10: Otters and prey: a.- *Lontra felina* eating a *Cancer* sp.; Caleta Camarones (19°12'36''S) 10/08/2000; b.- *Lontra provocax* feeding its young with a *Patagonotothen* sp. Fish; Magallanes: Isla Wellington (49°42'15''S/74°56'00''W); 01/01/2002. (Archivo WMV Video SONY Night Shot); c.- *Lontra felina* with a captured *Genypterus maculatus*; Iquique Port (20°12'34''/70°09'42''W); 30/12/2012; d.- *Lontra provocax* eating a *Sebastes capensis*; Puerto Gala, Aysén (44°15'27''S/73°12'33''W); 09/06/2013; e.- *Lontra felina* eating a fish; Isla Williams (44°54'19''S/74°24'09''W) 09/03/2021 (Photo: Juan Capella); f.- *Lontra provocax* with an octopus (Isla Carlos III (53°37'02''S/72°20'23''W) 02/03/2013 (Photo: Juan Capella).

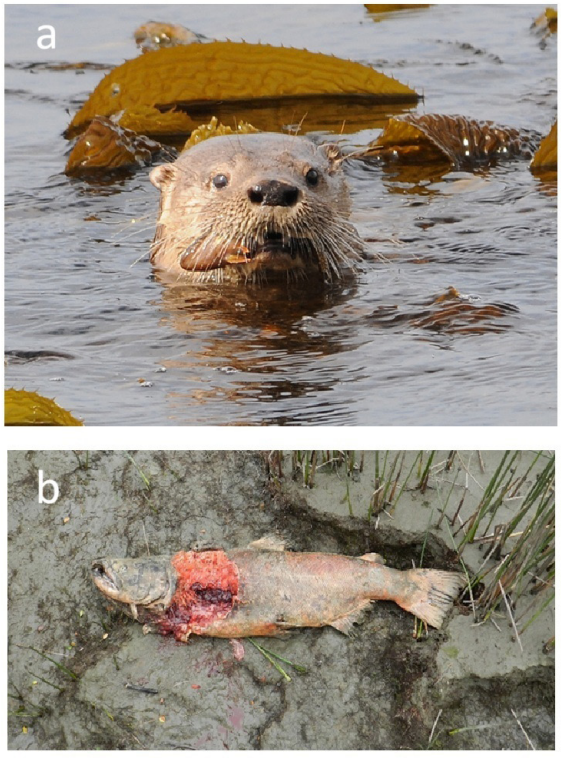


Fig. 11: Otters and prey: a.- *Lontra provocax* eating a *Patagonotothen*; Isla Carlos III (53°37'02''S/72°20'23''W) 02/03/2013 (Photo: Juan Capella); b.- A dead spawned chinook salmon (*Oncorhynchus tshawytscha*) partially eaten by *Lontra provocax* at Lucac river, Ofqui isth mus(46°44'12''S/74°09' 30''W); 10/03/2014.

In other less common species without otolith length conversion tables, *Cottoperca gobio* was found only once (otolith length 5.2 mm), *Trachurus murphyi* only once (otolith length 11.3 mm), *Salilota australis* found twice (otolith length 9.7 and 9.8 mm), and *Sebastes capensis* found once (otolith length 11.0 mm). However, the otolith length estimates suggest that these specimens were medium to large sized (20-60 cm S.l.).

The crustacean exoskeleton presented difficulties for size estimation because of extensive fragmentation during digestion. In the case of *Grimothea gregaria*, the most important species in the diet, a sample collected in the area showed C.l. of 25–39 mm (new original data).

The consumption of *Cancer edwardsi* is supported by exoskeleton fragments found in feces from the northern Magallanes area (sectors I and II) and two cephalothoraxes associated with trails/ eating places feeders from the same sectors. Both specimens are incomplete, but with an estimated C.w. of 10-12 cm (Table 8). The size of *Acanthocyclus albatrossis* and *Campylonotus vagans* could not be determined. In the case of *Lithodes santolla*, two specimens from feeding places had a C.l. of 9.3 and 8.7 cm. The consumption of sea urchins (*Loxechinus albus*) was represented by a single individual (30 mm in diameter) and *Pseudoechinus magellanicus* spines in feces (Table 8).

The mollusk predation focused on the most abundant species *Nacella magallanica* with feeding remains close to its maximum range (n=34; range 26-69 mm; mean 47.86 mm; sd. 1.560). Of the subtidal species, the following stood out: *Fisurella picta* (range=24-89 mm; n=10; mean 63.9 mm; sd. 19.29), *Fisurella oriens* (range=39-56 mm; n=4; mean 45.5 mm; sd. 7.36), *Plaxiphora aurata* (range=71-94 mm (n=6; mean 84.67 mm; sd. 8.262), *Odontocymbiola magellanica* (range=75 mm; *Trophon geversianus* 49 mm) (Table 8). Other mollusk remains did not allow size estimation due to its degree of shell destruction.

The individuals of the five bird species found associated to trails, feeding places and dens (*Spheniscus magellanicus*, *Leucocarbo magellanicus*, *Lophonetta specularioides*, *Tachyeres pteneres* and *Chloephaga hybrida*) represented adult individuals as could be verified by comparison with the reference material existing in the collection of the Patagonia Institute in Punta Arenas (new original data).

b.3. Huillin in inland waters

The most common prey of huillin in freshwater include small crustaceans of the genera *Aegla* (C.l. ≈ 30 mm), *Parastacus* (C.l. 70-100 mm), and *Samastacus* (C.l. 70-80 mm), and *Hemigrapsus crenulatus* and *Grimothea subrugosa* (length up to 39 mm and 34 mm, respectively), the last in the estuarine sector of the Negro River (Table 4). Fish are mostly small, with *Galaxias maculatus* (up to 15 cm T.l.), *Cheirodon spp.* (T.l. 3-7 cm), and *Percilia irwini* (up to 10 cm T.l.). Exceptions are *Percichthys trucha* (T.l. up to 50 cm), and the introduced species *Oncorhynchus mikiss* and *O. tshawytscha* and *Cyprinus carpio*, which are well above this size (Table 4). Prey sizes represent maximum size following Appendix, Table 1.

DISCUSSION

a. The huillin in inland waters

The lentic characteristics of the Boroa wetland (Caleta, Balsa Nigue, Puralaco, Puerto Ramos, Boroa, Boldo, Laguna Tromen, Laguna Patagua, Boroa Sur, Boroa Norte and Boldo Alto sites in the Queule River basin) are appropriate for the presence of the Chilean Helmeted Bullfrog *Caudiverbera caudiverbera*, part of the diet of the huillín in the river Queule basin (González & Medina, 2006). The estuarine zone of this river also generates appropriate conditions for the presence of *Hemigrapsus crenulatus* and the entry of the marine *Munida subrugosa* and *Odontesthes regia* indicated by González & Medina (2006) as part of the diet of the huillín in that sector. The consumption of these species accounts for the generalist and opportunistic nature that characterizes lutrinids in general (Biffi & Iannacone, 2010). The consumption of *H. crenulatus* by the huillín was also observed in various estuarine sectors of the Aysén Region (estuaries of the Palena and Frutilla rivers: Refugio Channel, San Tadeo River: Ofqui Isthmus) (pers. obs.). This species is native to the estuarine environments of New Zealand and Chile (Hicks, 1973; Pulgar *et al.*, 1995; Seneviratna & Taylor, 2006) and distributed from the Gulf of Penas to Iquique (Appendix: Table 1).

In other areas of Araucanian and the Chiloe regions, the presence of huillines is described as dependent on the consumption of crustaceans *Aegla*, *Samastacus*, *Virilastacus*, and *Parastacus* (Silva *et al.*, 2006; Fuentes & Arriagada, 2022). However, they also require larger prey items such as fish, amphibians, and birds for greater caloric and nutritional intake (Chehebar, 1985; Medina, 1997, 1998; Medina-Vogel, 2001; Medina-Vogel & González-Lagos, 2008). Franco *et al.* (2011, 2013) also reports consumption of the introduced species *Cyprinus carpio*, *Oncorhinchus mikiss* and *Salmo trutta* in wetlands associated with the Cruces and Bueno rivers (Araucanian Region). Meanwhile, in the contiguous Argentine territory where the huillín is mainly present around the "Nahuel Huapi" National Park, where its diet is made up of 99% crustaceans of the genera *Aegla* and *Samastacus* (Chehebar *et al.*, 1986; Chehebar & Benoit, 1988; Fasola *et al.*, 2021). Less frequently, it also preys on *Percichthys trucha* (Fasola, *op.cit.*).

Except for *Percichthys*, reaching 50 cm in length, and *Caudiverbera*, which is very locally present, all prey species are small, no larger than 10 cm in length (*Aegla*, *Samastacus*, *Parastacus*, *Percilia*, *Cheirodon*, *Galaxias*, and others) (Appendix, Table 1).

The oligotrophic/mesotrophic nature of these freshwater systems, their low productivity, the small size of the prey species, their low abundance and recruitment rates may represent fundamental factors for understanding the otter carrying capacity, densities (individuals/km of river) and home range extension (km of river) of the huillín in each system. If the presence of introduced salmonids (*Salmo fario* and *Oncorhynchus mikiss*) is added, species that also prey on some of these species, the availability of prey is even lower for the huillín. The absence of crustaceans in the continental waters of the Pacific slope south of 47°S [except for *Aegla alacalufi* which reaches the Duke of York Islands (Oyanedel *et al.,* 2011)] explains the absence of huillines in rivers and lakes of Magallanes and Tierra del Fuego. Temporary entries from the channels and fjords into freshwater are not excluded and are very probable in estuarine sectors.

Regarding *Samastacus* (river shrimp), *Parastacus* and *Virilastacus* (burrowing shrimp), their populations are affected by drainage of the wetlands (forestry and agricultural use and/or subdivisions for housing), chemical pollution (pesticides, fertilizers, sewage and wastewater), clearing and replacement of vegetation, trampling and soil compaction by livestock, modification of watersheds and channeling of water, and unregulated extraction of shrimp for human consumption (Silva & Spoerer, 2006; Rudolph, 2015). Furthermore, Silva & Spoerer (*op. cit.*) estimated an annual extraction of 43.5 million individuals in the Biobío Region alone, for which Rudolph (2013) estimates a total weight of 1525 t/year. The importance of these is highlighted when considering that shrimp catches for nylon shrimp (*Heterocarpus reedi*) in the Chilean sea fluctuate around annual quotas of 900 t, for yellow shrimp (*Cervimunida johni*) 1500 t and for red shrimp (*Pleuroncodon monodon*) 1000 t (Zilleruelo *et al.,* 2022).

For these reasons, shrimp populations are in a worrying situation, and their conservation status assigned by the Ministry of the Environment of Chile (MMA) do not appear to reflect their true status. *Parastacus pugnax* and *P. nicoleti* are classified as "insufficiently known" in central Chile and "vulnerable" in south-central Chile (Jara *et al.,* 2006; Rudolph, 2013). *Samastacus spinifrons* is classified as "least concern" (Jara *et al. op. cit.*), *Virilastacus araucanius* is "vulnerable," *V. rucapihuelensis* and *V. retamali* are "endangered," and *V. jarai* is "critically endangered" (Rudolph, 2015). The case of the 20 species of *Aegla* is not very different, with two species considered "extinct," three "endangered," and six "vulnerable" (Jara *et al.,* 2006).

This situation is particularly serious since their conservation status has not been updated in line with the increasing deterioration of the inland water system in recent decades. There are no measures regulating the indiscriminate capture of these species for consumption and in ecological terms, the effect of the disappearance/reduction of these species on their natural predators has not been assessed. It should be noted that, in addition also several species of coastal birds and fish prey these crustaceans, making the situation more critical.

As an opportunistic/generalist, in rivers and lakes affected by forestry, agriculture, and urban intervention, the lower availability of crustaceans and autochthonous slow moving fishes (*Diplomystes*, *Percichthys*) may eventually be compensated for by introduced species (*Cyprinus*, *Salmo*, *Oncorhynchus*). This could also explain the significant consumption of *Rattus rattus*, *Rattus norvegicus*, and *Oryctolagus cuniculus* reported by Medina *et al.* (2021) in the Toltén and Allipén river basins, and *Rattus norwegicus* reported by Franco *et al.* (2013) for Rio Cruces Natural Sanctuary.

In the same sector, and as reported using stable isotope techniques by Medina *et al.* (*op. cit.*), the huillines also consume salmon (*Oncorhynchus tshawytscha*) that enter the Toltén and Allipén rivers and tributaries to spawn. There is no information on whether they prey on live individuals or consume dead salmon post-spawning. However, records from the Lucac River: Ofqui Isthmus (pers. obs.) (Fig. 7) indicate consumption of dead salmon.

The return of chinook salmon to the rivers of Araucanía, Aysén, and Magallanes has not been evaluated in terms of its impact on native fauna. Considering that, for example, in the Toltén/Queule River system, 12,652 salmon measuring between 50 and 110 cm in length were recorded for the period 2014-15. These salmon entered the Toltén/Queule River system to spawn by ascending to Lake Villarrica and the Trancura and Liucura Rivers (FIPA Report, 2014-87), these relatively oligotrophic systems receive a substantial contribution of organic matter and nutrients.

Free living salmon spawning occurs between December and February, and post-spawning carcasses are concentrated between April and May (FIPA Report, 2014-87). Each season's juveniles are primarily concentrated in mountain rivers and tributaries of the Allipén, Negro, Penco, Zahuelhue, and Llaima rivers.

A similar situation has been previously described for the Petrohue River system (Bretón *et al.,* 2006), although its molecular genetic structure indicates that the two groups may have different origins (UDEC, 2016).

From a huillín conservation perspective, salmon rearing occurs between December and February, followed by the presence of carcasses in April/May, which corresponds to the final period of pregnancy for huillín females, lactation, and concern for the young in the litter (personal observations). Therefore, the salmon represents a potential food source during these critical periods. A similar situation has been described for *Lutra lutra* in Norway by Sortland *et al.* (2023). In turn, the presence of juveniles in the following months also constitutes a new feeding alternative in combination with the murids and rabbits already mentioned in the diet of the huillín by Medina *et al.* (2021).

Mollusks of the genus *Diplodon*, important in the diet of the huillín (Chehebar, 1985; Chehebar *et al.,* 1986), feed on phytoplankton and bacteria in habitats with high productivity (Vallejos, 1996). However, populations can only survive in mesotrophic to oligotrophic conditions, making them susceptible to eutrophication, which significantly reduces their distribution range (Fuentealba *et al.,* 2010). Modifications in parameters such as the sedimentation rate and bottom sediment removal have been shown to be key factors in the gradual decline of *Diplodon chilense* populations in Chile (Parada & Peredo, 1994).

b. The huillin in marine habitats

The diet of the huillín in the marine environment of Aysén is in complete relation with the transitional nature of the intertidal/subtidal fauna of this area, between the Chiloense and Magellan zones (Figs. 6, 7). In this sense, the diet mainly includes species typical of the Central Chilean and Chiloense zones (e.g., *Calliclinus* spp., *Bleniidae* spp., *Bovichthus chilensis*, *Aphos porosus, Normanichthys crookeri*, *Petrolisthes violaceus*, Cancer coronatus) with some species

typical of the Magellan zone (e.g., *Patagonotothen* spp., *Harpagifer bispinnis*, *Sprattus fuegensis*, *Zoarcidae* spp.) (Appendix: Table 1). Special mention should be made of *Centroscyllium granulosus*, cited by Choupay (2003) in 48–55% of the feces from the Estero and Golfo Elefantes (Bahía Exploradores and the Huillines and Gualas coves). In this regard, the identification made by Choupay (op. cit.) does not make clear whether it is *Centroscyllium granulatum* (Günther, 1887) or *Spinax granulosus* Günther, 1880 [currently accepted *as Etmopterus granulosus* (Günther, 1880)]. Both are deep-water species (300–1500 m) (Ebert, 2016) and even when present in the Aysén region (Zama & Cárdenas, 1984) under normal conditions they are outside the home range of the huillín.

In the Magallanes region, fish consumption focused primarily on *Patagonotothen/ Eleginops* species, which are the most common and abundant in the southern intertidal and shallow subtidal zones (Sielfeld *et al.,* 2006). Prey sizes estimated from otoliths found in scats corresponded to S.l. between 25 and 350 mm, with 88.9% of cases measuring between 50 and 125 mm (Sielfeld, 1989).

Other species from deeper strata (*Cottoperca gobio*, *Salilota australis*, and *Sebastes capensis*) were only represented by isolated individuals. Their consumption is probably greater than the record found in scats, given that, due to their size, they are generally consumed on land, excluding the head, so otoliths cannot be recorded in scats. The presence of *Genypterus blacodes* is supported by three skulls associated with a feeding place (Table 8).

Sebastes capensis is a subtidal species from a stratum generally outside the diving range known for otters in marine habitats (Nolet *et al.,* 1993: case of *Lutra lutra*: preferred diving depth 0–3 m; range 7 m). However, it undertakes nocturnal migrations to shallower areas, with some individuals remaining in the shallow sublittoral (Sielfeld *et al.,* 2006). A similar situation is also valid for *Salilota australis*.

Otoliths of *Sprattus fuegensis* (range 82.1–135.2 mm S.l.; mean 121.3 ±14.4 mm) in the feces (Sielfeld, 1984) is particularly noteworthy. This epipelagic species is common in Patagonian channels. Observations made on the Agwalisnan channel, Capitain Aracena island, showed that a nocturnal roundup of a school of sardines by sea lions in a rocky cove resulted in the stranding of a large number of individuals. These were consumed by otters and birds (*Nycticorax nycticorax*, *Milvago chimango*, *Caracara plancus*) (pers. obs. WS). The consumption of *Cancer edwardsi* and *Acanthocyclus albatrossi* in the northernmost part of the study area appears to be related to the distribution of these species. Although they are distributed as far as the Strait of Magellan (Retamal, 1981), they are abundant resources north of the Aysén and Chiloé regions (Meyer *et al.,* 2009).

Due to submersion limits of the huillín, in the case of *Lithodes santolla* only specimens associated with sublittoral macroalgal forests are likely available as prey. The intensive exploitation of this crustacean, focused primarily on intermediate zones (zones IV-VI) (Instituto de Fomento Pesquero, 2022), explains its consumption in the extreme zones (I-III and VII-IX) with lower fishing pressure (Sielfeld *et al.,* 2024) and probably more resource availability.

The analysis of otter food remains associated with trails, latrines, and dens play a fundamental role in defining the trophic spectrum of otters and understanding its role in the marine littoral ecosystem. In this sense, the remains effectively complement the information provided by fecal analysis identifying prey species they consume primarily on land, and are difficult to detect in feces,

The skeletal remains of birds associated with trails and feeding sites reported by Sielfeld (1984) (*Spheniscus magellanicus*, *Leucocarbo magellanicus*, *Lophonetta specularioides*, *Tachyeres pteneres*, and *Chloephaga hybrida*) are characteristic birds of the marine littoral of Patagonian channels and fjords (Barros, 1971; Castro, 2006; Delgado *et al.,* 2019; Olrog, 1950). The individuals were adults, but this study does not clarify whether they were healthy, actively captured prey or sick animals or even carcasses that were incorporated into the diet.

Only one specimen of *Loxechinus albus* (30 mm diam.; Table 8) was reported by Sielfeld (1984) in the Backout Sound: Trinidad channel (49°37′47′′S/74°28′42′′W). No consumption in other sites is probably related to a lower supply as prey according to the distribution of fishing areas reported by Jeréz *et al.* (1997) and Molinet *et al.* (2016).

The gastropods found around trails and dens (*Fisurella picta*, *F. oriens*, *Argobuccinum* sp., *Plaxiphora aurata*, *Acanthina monodon*, *Tegula atra*, *Odontocymbiola magallanica*, *Trophon geversianus*) are the largest species among the mollusks found in association with the coastline of fjords and channels (Molinet *et al.,* 2000; Ojeda *et al.,* 1984; Ríos *et al.,* 2007). *Concholepas concholepas* was not found to be consumed, consistent with its absence in channels and fjords, and inhabiting the oceanic coast from southern Peru to the Diego Ramírez Islands (Rosenfeld *et al.,* 2020).

Clamys patagonica, normally associated with snowdrifts, was only found in a fecal sample from Caleta Olla, a sector adjacent to the Holanda and Italia glaciers, Northwest Arm of the Beagle Channel.

c. The chungungo on the Pacific coast

The low similarity values (Bray Curtis; < 0.6 bits) between feces along the latitudinal gradient (20°-56°S) (Fig. 5) indicate local trophic behaviors related to changes in food supply associated with the biogeographic structure of the extensive southeastern Pacific coast (Figs. 8, 9) (Camus, 2001; Ojeda *et al.,* 2000; Retamal & Moyano, 2010; Sielfeld & Villegas, 1999; Sielfeld *et al.,* 2010). Especially the biogeographic changes experienced by crustaceans along the Chilean coast (Retamal & Moyano, 2010) and littoral fish (Sielfeld *et al.*, *op. cit.*) (Figs. 8, 9) show a direct relationship with the latitudinal changes (Fig. 5) that characterize the diet of the chungungo from Peru to Cape Horn.

Information on the feeding of chungungo along the Peruvian coast is scarce and reported by Biffi & Ianacone (2010) for Tacna, Peru. The identified prey includes *Sciaena* sp. and *Trachurus murphyi* in a otter population associated with the Morro Sama fishing village and *Labrisomus* and *Aphos* in the population of Quebrada Burros. The last one would be less human intervened, however, both are considered "active fishing ports" associated with the presence of dogs, cats and rats (Mangel *et al.,* 2010; Pizarro-Neira, 2014). In the first case, the consumption of coastal/oceanic pelagic *Trachurus* and *Sciaena* may probably result from the ingestion of fishermen's discards. The consumption of only *Labrisomus* and *Aphos* in the second case is probably a result of overfishing of other species typical of the rocky coast of the area, such as those consumed by the chungungo in Punta Patache in the northern sector of Chile (WS new data).

Pizarro-Neira (2014) in his report for Vila-Vila fishing village reported the consumption of the above species together with *Acanthistius pictus*, *Cheilodactylus variegatus* and *Chromis crusma*.

A comparison of the prey species reported for southern Peru by Pizarro-Neira (2014) and Biffi & Iannacone (2010) with those from Punta Patache in northern Chile (new data) reveals a range of shared prey items, including *Acanthistius pictus*, *Cheilodactylus variegatus*, *Chromis crusma*, and crustaceans of the genera *Allopetrolisthes*, *Petrolisthes*, *Pachycheles*, *Grapsus*, and *Pilumnoides*. In the Chilean sector south of Pan de Azucar (24°40′S) the most important crustacean prey are *Taliepus dentatus*, an herbivorous species associated to kelp beds, *Homalaspis plana*, *Paraxanthus barbiger* and species of *Cancer* (Table 10).

Mangel *et al.* (2010), in referring to Morro Sama and Vila-Vila of southern Peru, mention records from direct observation (40.6 and 48.2% fish, 44.7 and 21.7% crustaceans, and 0.2 and 0.0% mollusks, respectively) and analysis of 101 fecal samples collected between Ilo and Vila-Vila, with ≈36% crustaceans and ≈64% fish. Other data come from Ovalle (2006), which only mentions fish and crustaceans in general.

In the case of Punta Patache (20°45′S), the wide variety of recorded fish prey probably results from the relatively pristine characteristics of this sector, where at the time of the study there was no shore fishing or intensive exploitation of brown macroalgae, favoring the presence of *Acanthistius*, *Cheilodactylus*, *Chromis*, *Nexilosus*, *Semicoscyphus*, *Graus*, *Pinguipes*, *Auchenionchus* in the shallow subtidal (Cisternas & Sielfeld 2008; Villegas *et al.,* 2018 b). Visual records in the sector also indicated predation by *Paralabrax humeralis* and *Genypterus* sp. In this zone (pers. obs. WS.).

In the southern zone south of the Taitao Peninsula (49°-56°S) fish consumption is focused on *Cottoperca*, *Eleginops*, and principally *Patagonotothen* species (17-37% of the feces) (Table 10) which are the main and most frequent fish genus in these sectors (Sielfeld *et al.,* 2006; Vanella *et al.,* 2007).

The scats from the intermediate zone of Chile, between Pan de Azúcar and Valdivia (24°40′S–39°40′S) revealed that otters prey on a typical central Chilean group of fishes (*Cheilodactylus*, *Aplodactylus*, *Chromis*, *Nexilosus*, *Girella*, *Genypterus*, *Prolatilus*, *Pinguipes*, *Eleginops*, *Bovichtus, Sicyases*, *Paralichthys*, *Calliclinus*, *Myxodes*, *Scartichthys*) commonly associated with rocky shorelines and macroalgal belts (Pérez-Matus *et al.,* 2007). Of these species, the most consumed species in Pan de Azúcar and Choros Island are *Scartichthys* most species (24.0% and 23.2% of the scat, respectively; Table 8), non-commercial species, probably consumed as consequence of the reduction of other species due to fishing and the degradation of their habitat due to the exploitation of brown macroalgae and associated resources. This same reason probably also leads to a higher consumption of crustaceans in these areas (Table 8).

A lower fish consumption in this area has been previously highlighted by Biffi & Ianacone (2010) and used by Hostos (2021) to support the existence of distinct ecomorphotypes for the Peruvian coast and central Chile. A piscivorous ecomorphotype from the Peruvian coast (flat and narrow skulls, more elongated braincases, more elongated jaws, and larger angular processes) and a durophagous ecomorphotype from the Chilean coast (shorter, convex, and wider skulls, larger molariform areas, and shorter jaws).

This northern form was recognized early by Gervais (1841) and described as *Lutra peruviensis* Gervais, 1841 on material from San Lorenzo Island, near Callao, but posteriorly found to be doubtfull by Osgood (1943) a criterion apparently also shared by Apablaza & Romero (2012).

More to the south, the Chiloé and Guafo Island areas correspond biogeographically to a transition zone of invertebrates and fishes between central Chile and the Patagonian region (Figs. 8, 9).

In the Patagonian region (Aysén and Magallanes) the chungungo's consumption of birds plays a more important role than in central and northern Chile, involving 10 species common to the marine littoral (*Chloephaga hybrida*, *Tachyeres pteneres*, *Lophonetta specularoides*, *Larus dominicanus*, *Leucosphaeus scoresbii*, *Sterna hirundinacea*, *Nycticorax nycticorax*, *Milvago chimango*, *Leocarbo atriceps*, and *Leucocarbo magellanicus*). This contrasts with the less diverse bird consumption (only 5 species) found for the same area in the huillín. However, it should be noted that on the oceanic coast of Magallanes, the abundance of birds is significantly greater than on the coast of channels and fjords (Sielfeld 1982 a, b), and therefore their availability as prey.

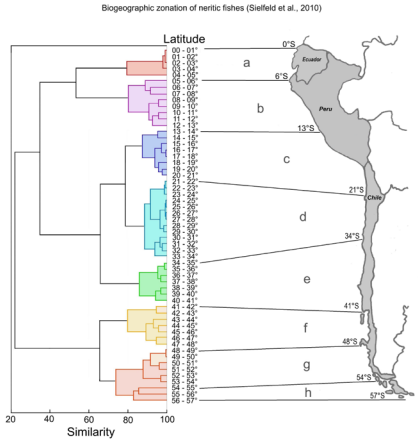
In general, except for a chick/juvenile of *Pelecanoides garnoti* from the Choros Islands (Mattern *et al.*, 2002; Villegas, 2002), the chungungo does not prey on chicks and eggs of seabirds judging by the fecal contents and food remains described in this study, being probably an evolutionary adaptation by the birds to look for nesting sites less susceptible to predation.

Finally, a report of stomach contents from Chiloé: Quilán Island (43°25'S/74°20'W), yielded *Emerita analoga*, *Homalaspis plana*, *Pyura* sp., and *Loxechinus albus* (Rozzi & Torres-Mura, 1990). The assumption that "barnacles are the major prey for *L. felina*," formulated by Biffi & Iannacone (2010), and the insistence on this by Valle & Indacochea (2024), who stated that "barnacles, chitons, and bivalves are favored prey for *Lontra felina*" (Biffi & Iannacone, 2010) has little scientific support, and the present data does not provide any background to support this theory.

The found niche breath (H'est and B A) in the chungungo (Fig. 9) show higher values in the northern and southern sectors of the study area, consistent with an intermediate zone with lower supply of prey species due to environmental deterioration. Although diversity (Shannon-Wiener index) is not directly related to niche breadth, but rather to species richness (number of species) and equity (uniform distribution of individuals) the niche breath is in contrast with a greatest dietary diversity at intermediate latitudinal levels and minimum values at the northern and southern extremes as described by Córdova *et al.* (2009) for part of the same area.

d. Ecological role of the huillín and the chungungo

Lontra felina is part of the intertidal kelp forest ecosystem of intertidal *Durvillaea*



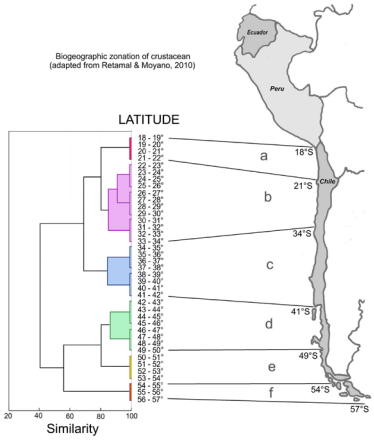


Fig. 12: Biogeographic zoning of neritic fishes (from Sielfeld *et al.* 2010): a.- Ecuadorian region; b.- Peruvian region; c.- Chile Peruvian mixture region; d.- North Chilean region; e.- Central Chilean region; f.- Chiloean region; g.- North Magellan region; h.- South Magellan region (Not official nomenclature; for

Fig. 13: Biogeographic zoning of crustaceans (adapted from Retamal & Moyano 2010): a.- Chile Peruvian mixture region; b.- North Chilean region; c.- Central Chilean region; d.- Chiloean region; e.- Chiloean region; f.- Magellan region (Not official nomenclature; for present purposes only).

antartica (Chamisso) Hariot, 1892 and *Lessonia spicata/nigrescens/berteroana* complex (Martin & Zucarello, 2012) and subtidal *M. integrifolia* Bory, 1826 (syn. *Macrocystis pyrifera* (Linnaeus) C. Agardh, 1820) and *Lessonia trabeculata* Villouta & Santelices, 1986 and understory crustose algae and patchy assemblages of foliose algae (Pérez-Mattus *et al.* (2017).

Lontra provocax inhabits *Lontra provocax* channels and inland sounds of the Patagonian archipelago characterized by extense subtidal *Macrocystis integrifolia* forests understory foliose algae, like *Gigartina* and *Epymeria* (Rios & Mutschke, 2009).

Under these conditions, the otters play an important role interacting with other organisms, contributing to the functioning and structure of the ecosystem, and including how they feed.

The invertebrates preyed upon by the chungungo and the huillín in the marine environment are part of the community associated to *Lessonia berteroana* (Romo & Alvear, 1977; Soto, 1997), *Macrocystis integrifolia* and *Lessonia trabeculata* (Vásquez *et al.,* 2001; Villegas *et al.,* 2018 a; Adami & Gordillo, 1999) and *Durvillaea antartica* (Mansilla & Avila, 2007; Ríos *et al.,* 2007).

A special mention deserves *Taliepus dentatus* which depends trophically and environmentally on on the kelp beds and being a fundamental prey species of the chungungo from north-central to south-central Chile, turns the exploitation of brown algae in a potential threat for the otters.

The fish in the otter diet are also part of kelp forests (Moreno & Jara, 1984; Angel & Ojeda, 2001; Perez-Mattus *et al.,* 2007, 2012; Hüne *et al.,* 2021; Friedlander *et al.,* 2018, 2021), which offer protection from predators and invertebrate-based feeding (Vargas *et al.,* 1999; Berrios & Vargas, 2004). Of these fish, *Acanthistius*, *Cheilodactylus*, *Chromis*, *Nexilosus*, *Semicoscyphus*, *Graus*, Pinguipes, *Auchenionchus*, and *Labrisomus* are common species in the north and north-central zone of Chile (Pérez-Mattus *et al., op cit*.) while *Patagonotothen* and *Cottoperca* are Patagonian species (Moreno & Jara, 1984; Hüne *et al*., 2021). Exceptions are epipelagic species (*Engraulis*, *Sprattus*, *Trachurus*, *Stromateus*) and species from deeper strata (*Salilota*, *Genypterus*) occasionally consumed by these otters.

Other invertebrates in the otter´s diet belong to several functional groups, including filter feeders of suspended material (*Mytilus*, *Semimytylus*, *Aulacomya*, *Gaimardia*), algivores (T*etrapygus* and *Loxechinus*, *Fisurella*, *Scurria*, *Nacella*, *Tegula*, *Plaxiphora*, *Chiton*), consumption of polychaetes, algae, organic material (*Munida*), consumption of bryozoans and *Lessonia* (*Taliepus*), predation of bivalves, snails and urchins (*Odontocymbiola, Concholepas*), predation of crustaceans and urchins (*Argobuccinum*), predation of mussels (*Acanthina*, *Trophon*), consumption of polychaetes, amphipods, bryozoans, sponges (*Pisoides*), predation of mussels, *Acanthina*, *Tegula*, *Jehlius* (*Acanthocyclus*), carnivorous regime, scavenger and detritivores (*Cancer*, *Homalaspis*, *Paraxanthus*), consumption of detritus and organic matter (*Rhyncocinetes*, *Campilonotus*), carnivores and detritivores (*Petrolisthes*, *Allopetrolistes*, *Liopetrolistes*, *Pachyceles*, *Megalobrachium*) (Zagal & Hermosilla, 2001; Meyer *et al.,* 2009; Zelaya, 2009). For details see: Appendix, Table 1).

Also, part of this food web are *Tachyeres pteneres* (a predator of crustaceans and benthic mollusks), *Chloephaga hybrida* (a foliose algae eater), *Leucocarbo magellanicum* (ichthyophagous diet), *Nycticorax nycticorax* (intertidal fish and invertebrates), and *Larus dominicanus* and *Milvago chimango* (shore scavengers). All these birds are integral part of the trophic spectrum of huillín and chungungo in the marine environment.

In comparison, in marine habitats both otters (chungungo and huillín) feed primarily on carnivorous species (41-54% of the species) (Table 14), represented primarily by secondary carnivores (fish and crustaceans). In chungungo on the northern and central coast of Chile omnivores represent 3.8-8.0%. Herbivores reach 9.4-9.6% on the northern and central coast of Chile but rise to 15.4-20.0% for *L. felina* and *L. provocax* respectively in southern Chile. Scavengers, detritivores, and filter feeders remain between 4.0% and 15.6%. All these groups are significantly interrelated (Villegas *et al.,* 2008 a), so the removal of one or more species may induce alternative shifts in energy flow (Graham, 2004; Graham *et al.,* 2007) with potential effects on the dynamics and structure of macroalgal forests and the associated community.

The prey spectrum identified in feces of the chungungo along its distribution range (Table 15) includes 197 species. Of them 42.13% crustaceans and 33.50% fishes. Most of them are slow moving benthic species. By sector prey species reached up to 33 species (mean = 16.41; Ds 9.12). Sectors with adverse impacts (Intense shellfish extraction, fishing, habitat degradation, fragmentation, contamination, etc. like Pan de Azucar, Chome, Chiloé) prey is reduced to 4-9 species and indicates the importance of sites with low human impacts to ensure presence and distribution of these otters.

The marine population of huillin in fjords and channels has a narrower species spectrum of prey as identified in feces, if compared with the chungungo with 89 species of them 33.7% are crustaceans, 32.6% mollusks, 24.7% fishes, 5.6% birds and 2.2 % sea urchins (Table 16). By sectors 3-15 prey species (mean = 9.89; Ds. 3.92).

In freshwaters of Chile, the trophic spectrum of the huillín is markedly simple. 50.0% of prey species are carnivorous (primarily fish) and 28.6% are omnivorous (crustaceans). Both groups thrive primarily in oligotrophic and mesotrophic conditions.

The most productive marine environments determine smaller home ranges, estimated at more than 7 km for huillines by Medina-Vogel *et al.* (2013) and between 1.47 and 4.13 km for chungungo by Medina-Vogel *et al.* (2007). In Magellanic channels and fjords a density of 0.28-0.75 huillines/km was estimated by Sielfeld (1985) and in continental habitats a density of 0.25 huillines/km in the Queule River: IX Araucanía Region and an estimated average home range of 11 km (Sepúlveda *et al.,* 2007).

These values are consistent with reports for *Lutra lutra* in Austrian rivers, with 0.22-0.23 ind/km of river (Sittenthaler *et al.,* 2015), and 0.22-0.23 ind/km in Portuguese rivers (Quaglietta *et al.,* 2015). For the same species in marine littoral, 0.33–0.55 ind/km (Erlinge, 1968, 1969) and probably >1 ind/km (Kruuk & Hewson, 1978) are reported. Boyle (2006) and Melquist & Hornocker (1983) reported 0.25 and 0.4 ind/km for *Lontra canadensis* in North America, and Parera (1993) 1.5–2.6 ind/km for *Lontra longicaudis* in Corrientes, Argentina.

When processing this information, it should be noted, however, that otter densities are often overestimated (Quaglietta *et al.,* 2015) because the study areas frequently only correspond to small areas of river and coastal extension [0.20 and 1.49 km (García *et al.,* 2009); 12 km (Ruiz-Olmo *et al.,* 2001); 10–12 km as the only sampling in 30 km of river (Ruiz-Olmo *et al.,* 2011)].

Table 14: Trophic levels of identified prey species in feces of huillín and chungungo (from Tables 4, 7, 10; Appendix table

Species	*Lontra felina*						*Lontra provocax*			
Sectors	North		Central		Austral		Marine		Freshwater	
Species	n	%	n	%	n	%	n	%	n	%
Carnívores	15	46.9	28	53.8	11	44.0	16	41.0	7	50.0
Omnivores	2	6.3	2	3.8	2	8.0	2	5.1	4	28.6
Herbivores	3	9.4	5	9.6	5	20.0	6	15.4		
Scavengers	2	6.3	6	11.5	3	12.0	3	7.7		
Detritivores	5	15.6	6	11.5	2	8.0	6	15.4	1	7.1
Filter feeding	4	12.5	4	7.7	1	4.0	4	10.3	2	14,3
Planktophages	1	3.1	1	1.9	1	4.00	2	5.1		
Totals	32	100.0	52	100.0	25	100.0	39	100.0	14	100.0

Table 15: Number of identified prey species in feces of chungungo along the latitudinal gradient (18°-56°S)

Prey species	Tacna	Patache	Pan de Azúcar	I. Choros	Caleta Chome	Sn. Vicente	Valdivia	Chiloé	I. Guafo	I. Stosch	I. Stewart	S. Año Nuevo	**Total**
Fishes	4	11	5	7	1	1	10	3	14	4	3	3	**66**
Crustaceans	10	16	4	12	4	2	11	3	6	6	4	5	**83**
Mollusks	2	4		3		1	2		1	6	2	11	**32**
Sea urchins		1								1	1	1	**4**
Birds		1			1					2	1	6	**11**
Mammals											1		1
Total	16	33	9	22	6	4	23	6	21	19	12	26	197

Table 16: Number of prey species of the huillín in channels, fjords and sounds of the Magallan region (48°41'-55°23'S).

Prey species	Canal Fallos	Canal Trinidad	Canal Concepción	Canal Esteban	Canal Uribe	W Entr. Magellan Straits	Golfo Xaultegua	Canal Beagle	S. Año Nuevo	**Total**
Fishes	2	3	4	2	1	2	3	3	2	**22**
Crustaceans	4	5	4	1	1	3	5	3	4	**30**
Mollusks	4	6	3		3	2	1	8	2	**29**
Sea urchins		1						1		**2**
Birds	1				1	1	1		1	**5**
Mammals							1			1
Total	11	15	11	3	6	8	11	15	9	89

CONCLUSIONS AND SITUATION OF OTTERS IN CHILE

Most studies on the feeding habits of chungungo and huillín have focused on descriptive studies of the trophic spectrum, comparative studies between sectors (Medina, 1995; Medina *et al*., 2004; González & Medina, 2006; Parra, 2006; Poblete *et al*., 2019; Biffi & Iannacone, 2010, among others), comparisons between the trophic behavior of the two species (Sielfeld, 1989; Ebensperger & Botto-Mahan, 1997; Sanino & Meza, 2016), foraging, coastal use, and prey selectivity (Villegas, 2002).

The existing information on feeding of huillín and chungungo is mostly very local, involving spatial changes, except for the study of temporal variations by Franco *et al*. (2013). Apart from the normal seasonal changes, the coast of the southeastern Pacific is affected by periodic changes such as El Niño/La Niña and at a global level, by the Global Warming, of which the consequences on the huillín and chungungo and their physical and trophic niche, have not been evaluated.

Any diet analysis must be embedded in time and space, and within a dynamic process that results in temporal and spatial variation in dietary composition (Somers & Nel, 2003). Temporal variations are generally influenced by prey activity and abundance (Carss, 1995), thus including the effect of fishing, while spatial variations have been attributed to differences in the utilized habitats (Litvaitis, 2000). Neither the effect of fishing, shellfish extraction, installation of management areas, nor other types of coastal intervention have been seriously assessed for environmental impacts on huillín and chungungo (Acevedo *et al*., 2019), even though there are well-founded suspicions about their probable effect on otters (Delgado-Rodríguez *et al*., 2006; Medina-Vogel *et al*., 2007).

The huillín and the chungungo are generalists with a wide range of prey and opportunistic species in the sense used by Chanin (1985), which feed primarily on fish and crustaceans. They are also selective in that they do not always feed on the most abundant prey (Geidezis, 1996).

Considering the diverse trophic levels of the otter's prey species, both otter species occupy a mid-upper trophic position, as indicated for freshwater populations by Franco *et al*. (2013), playing a fundamental role in nutrient transport and the processes that contribute to and maintain ecosystem stability. Consequently, they are key species in the functioning of coastal ecosystems, their productivity, biodiversity, balance, and stability. Their presence should therefore be recognized as a fundamental indicator of a healthy environment and ecosystem.

The narrow trophic niche of the huillín and chungungo and the local dependence on only a few food items, make them highly vulnerable to the reduction of their prey species, especially those being important artisanal fishing resources such as *Loxechinus albus*, *Homalaspis plana*, *Cancer coronatus*, *Cancer setosus*, *Platyxanthus dorbigny*, *Taliepus dentatus,* fisurellids and rock fishes.

Due to the ecosystem structuring nature of the rocky coastal kelp beds, their commercial extraction entails significant changes in the fish and invertebrate community (Pérez Mattus *et al*., 2007; Villegas *et al*., 2018 a, b), resulting in a reduction in food availability for otters (Villegas *et al*., 2007). The actual kelp harvest regulations do not consider these effects.

The increasing pollution, the coastal edge intervention and shoreline use in Northern and Central Chile are entail modifications and fragmentation of the physical habitat of the chungungo

(Gutiérrez *et al*., 2019), but also leading to the reduction of inter- and shallow subtidal prey species, such asgrapsids (*Grapsus*, *Leptograpsus*, *Cyclograpsus*) and porcellanids (*Allopetrolisthes*, Petrolisthes, *Liopetrolisthes*, *Pachycheles*) affecting prey availability for the otters.

In the case of the freshwater populations of the huillín, the crustaceans (*Aegla*, *Samastacus*, *Parastacus, Virilastacus*) that constitute the basis of the diet of the huillín are threatened by pollution, modification of river basins and flows that also affect fish (*Cheirodon*, *Percichthys*, *Percilia*, *Diplomystes*). An additional aspect not evaluated to date is massive, unregulated fishing of *Virilastacus* (Burrowing shrimp), extensive to the wetlands of the Araucanian Region.

In Southern Chile, the presence of feral Chinook salmon (*Oncorhynchus tshawytscha*) deserves special considerations. During their growth phase, they consume *Patagonotothen* fish species (PA 38.2%; FA 69.2%), crustaceans (PA 30.3%; FA 7.7%) including prawn *Munida gregaria* (PA 7.3%; FA 3.9%), among other prey (Oyarzún, 2011). Due to their coastal nature and the large number of returns reported for several rivers in the area (Bretón *et al*., 2006; FIP Report, 2014-87), they constitute a potential danger due to competition with otters for similar food resources.

The low variety of prey found in Chome (6 items) and San Vicente (5 items) (Poblete *et al*., 2019), Calfuco (8 items) and Pilolcura (6 items) (Solari, 2024), all of them sectors with intense fishing activity and use of the coastal edge, contrast with sectors less influenced by anthropogenic factors such as Punta Patache (36 items; this work), Valdivia (25 items) (Medina *et al*., 2004) and Guafo (21 items) (Núñez, 2014). As Medina-Vogel *et al*. (2004) have pointed out, sectors with a marked anthropogenic influence would affect the availability of prey and provide additional food sources such as, for example, fishing discards.

Valqui (2012) and Gutiérrez *et al*. (2019) have suggested that the chungungo would present capacities to adapt to habitat changes and human disturbances and Cursach *et al*. (2012) consider the chungungo a synanthropic species. However, there is a lack of studies that report on the health status of otters living in polluted environments of coves and ports (hydrocarbons, wastewaters, desalination plant waste, industrial plants, etc.), alterations in prey diversity, abundance and increased prey capture effort (due to pollution, shore fishing, macroalgae exploitation, coastal edge alterations), an aspect analyzed by Gutiérrez *et al*. (2019), consequences on health of the consumption of discards and fishing waste, effects of all the above on nutritional and health parameters, adult survival and mortality rates, litter success and recruitment rates, alteration and interruption of biological corridors between families/population nuclei restricted to rocky sectors, the effect of the presence of dogs in urban/peri-urban sectors, among other aspects.

The situation of the huillín in inland waters is undoubtedly the most worrying, considering that it is trophically dependent on a few species of shrimp and fish, which are sensitive to pollution, eutrophication, wetland desiccation, and watershed management (masonry, gabions, rockfill, channelization etc.). Added to this, in some areas, is the uncontrolled extraction of shrimp for human consumption (Silva & Spoerer, 2006; Rudolph, 2015) and the agriculturalization of surrounding areas, land use change, and urban land subdivisions, which have even led to the consumption of *Rattus rattus*, *Rattus norvegicus*, and *Oryctolagus cunniculus* by the huillin (Franco *et al*., 2013; Medina *et al.,* 2021).

Current protection measures for the huillín and chungungo in Chile do not safeguard the non-intervention of their habitat and do not ensure adequate access to their habitual food

sources. These aspects are not considered in environmental studies (EIA, DIA) associated with the Environmental Bases Law of Chile (Law 19,300 and its amendments) or in the coastal use policy, the subdivision of the coastal border for the extraction of shellfish, fish, and algae, among other aspects associated with the General Fisheries and Aquaculture Law of Chile (Law 18,992 and its amendments). There is urgent need to establish protected areas that include the inter- and shallow subtidal zones and excluding fishing and shellfish extraction activities. The design of these areas must also safeguard gene flow between them and the existence of genetically sustainable populations by considering biological corridors. As marine mammals, sea otters are part of the species with the greatest conservation challenges in Chile and around the world (Valqui & Rheingantz, 2015). The chungungo and the huillín are among the species most vulnerable to human activity due to their use of the rocky coastal edge, which represents their habitat for feeding, resting, and establishing burrows (Estes *et al*., 1978; Rozzi & Torres-Murra, 1990; Kreuder *et al*., 2003; Medina-Vogel *et al*., 2007).

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