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ARTÍCULO POR INVITACIÓN

THE IMPORTANCE OF GREY LITERATURE IN FISHERIES ECOLOGY: AN EXAMPLE BASED ON THE TROPHIC ROLE OF SMALL PELAGICS IN THE GULF OF CALIFORNIA

Tripp-Valdez[1], M. A., S. E. Lluch Cota*[1], P. Del Monte Luna[2] & C. Salvadeo[2]

[1]Centro de Investigaciones Biológicas de Noroeste (CIBNOR), Mar Bermejo 195, Playa Palo de Santa Rita, La Paz, B.C.S. 23096, México. [2]Centro Interdisciplinario de Ciencias Marinas - Instituto Politécnico Nacional (CICIMAR), Av. Instituto Politécnico Nacional s/n., Col. Playa Palo de Santa Rita, La Paz, B.C.S. 23096, México. *Corresponding author. Tel.: +52 (612) 123-8484 ext. 3432. Fax: +52 (612) 125-3625. e-mail: slluch@cibnor.mx

RESUMEN. La literatura gris suele considerase como una fuente de información cuestionable en revistas y publicaciones científicas debido a que carece de una revisión especializada y a que puede constituirse de documentos difíciles de rastrear. Sin embargo, brinda información detallada y de calidad que no se encuentra en las publicaciones con arbitraje estricto. Con el objetivo de ilustrar la importancia de la literatura gris en el ámbito de la ecología pesquera, se realizó una búsqueda en línea de publicaciones en revistas indexadas, en tesis de grado, reportes técnicos y resúmenes de congresos donde se reportan las relaciones tróficas de los pelágicos menores con especies de diversos taxa en el Golfo de California. Se obtuvieron 57 referencias bibliográficas de las cuales 36 son consideradas como literatura gris. Excluir los datos contenidos en estas fuentes de los análisis que se lleven a cabo sobre el tema, podría representar una pérdida de más del 60% de la información disponible. Este sesgo tiene el potencial de producir conclusiones incompletas o erróneas en los estudios de la dinámica trófica de los pelágicos menores en el Golfo de California.

Palabras clave: Pelágicos menores, Golfo de California, revistas no arbitradas, revistas ISI.

La importancia de la literatura gris en la ecología pesquera: un ejemplo basado en el papel de los pelágicos menores en el Golfo de California

ABSTRACT. Grey literature has been, in general, rejected from peer reviewed journals due to the lack of specialized revision and because they are difficult to trace. However, this information may contain detailed data that cannot be found in commercial reviewed journals. In order to assess the importance of grey literature in fisheries ecology, we made an online survey of indexed journals as well as thesis dissertations, technical papers and abstracts from proceedings reporting the trophic relationships of small pelagic fish in the Gulf of California. We obtained 57 bibliographic references from which 36 are considered grey literature, and these would represent a loss of more than 60% of information. This bias can lead to erroneous conclusions in studies and applications derived from such information.

Keywords: Small pelagic, Gulf of California, non-indexed journals, ISI journals.

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INTRODUCTION

The main way in which scientists communicate their research results is through peer reviewed scientific journals. This allows the generated knowledge to be subjected to a rigorous review process and validation from specialists and also to be widely distributed among the scientific community.

Scientific research also produces an important amount of information as technical reports, atlases, congress and symposium proceedings, taxonomical keys and thesis dissertations. Such sources of information, generated at all levels of government, academy, business and industry, that are not controlled by commercial publishing circuits, is known as

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"grey literature" (opposed to the "white" or "open literature" that includes journal articles or books; Cassell, 2005; De Castro, 2006). Despite that this literature may contain valuable information, it tends to be rejected as much as possible from peer reviewed journals, mainly because it is not indexed and thus it can be very difficult to trace and acquire. Also, the lack of strict editorial controls cast doubt on the veracity of its contents (Lacanilao, 1997; Mathews, 2004).

Although the peer reviewed system has been a rather efficient quality control for scientific publications, it is not flawless. Students and researchers keep publishing only their more relevant results or those that have some importance for economical o political issues (Bank, 2006).

Grey literature may fill this gap because it contains detailed information (equipment description, proceedings, raw data, tables, graphics, etc.) which is usually not published in peer reviewed journals due to space limitations or because this information is not useful for a wider audience (De Castro, 2006).

In recent times, the world wide web has facilitated the publication of raw data or supplementary material in journals, however, in Latin America and other developing countries grey literature still plays an important role because scientist, especially graduate students, still use and produce this information, but do not usually publish their results in peer reviewed journals (De Castro, 2006; Thatje *et al*., 2006).

For instance, Sáenz-Arroyo *et al*. (2005) made an exhaustive search of fishery reports from international, national and local libraries (*i.e.*, grey literature) and interviews with local fishermen to address the status of the gulf grouper (*Mycteroperca jordani*). They found that there is a considerable decrease in abundance of this species inside the Gulf of California, contrary to what has been found using fisheries models. Thatje *et al*. (2006) found that grey literature is a very valuable source of information about the ENSO effects in the Humboldt Current System. More than half of this information is in Spanish, which represents an important barrier for its worldwide dispersion.

In this study, we illustrated the importance of using grey literature, *i.e*., graduate and post graduate dissertations and technical reports, focusing on the trophic relationships of small pelagics in the Gulf of California.

METHODS

We made an online bibliographic survey in several databases: the ISI Web of Knowledge, Google Scholar web search engine and FISHBASE (www.fishbase.org) using the words "prey", "Gulf of California", "Feeding ecology" and "small pelagic". Likewise we surveyed the FISHBASE database for feeding habits of many of pelagic fish of economical importance in the Gulf of California.

We also searched for graduate and post graduate dissertations addressing the trophic ecology, feeding habits, biology and abundance of several species related with the small pelagics in the Gulf of California. Our search was conducted in the on-line public libraries of different research institutions: CIBNOR (www.cibnor.gob.mx), UABCS (http://biblio.uabcs.mx/), UABC (http://sia.mxl.uabc.mx/), CICESE (http://.biblioteca.cicese.mx) and CICIMAR (www.biblioteca.cicimar.ipn.mx/oacis) for postgraduate dissertations. Electronic versions of the documents (PDF) were obtained.

We made a database including the species that feed upon small pelagics and the region of the Gulf of California and the date when the information was obtained, the importance of small pelagics in the diet composition (percentage), and the species that comprise the diet.

We made a list of the main fishery journals in the Science Citation Index 2008. Guides for authors were revised to identify the policy of each journal concerning grey literature, *i.e.*, if they allow the use of dissertations, technical reports, abstracts, etc. In the case of those journals that do not specify the use of grey literature, we made a thorough revision of all articles from the two most recent issues of each journal looking for trends in the use of grey literature. Finally we analyzed the amount of whole database that woud be eliminated in case of rejection of grey literature.

RESULTS

From the bibliographic online survey, we obtained information of 36 species from four different taxa that feed upon small pelagics in the Gulf of California (Table 1 on the appendix) contained in 57 documents from which 21 are articles published in peer reviewed journals or

doctoral (PhD) theses, both considered as white literature; 23 are Master´s (MSc) thesis; 8 Bachelor´s degree (BSc) theses; two conference proceedings and three technical reports.

Eight of the indexed journals do not allow the use of any kind of grey literature in their reference list; unpublished data must be cited as such in the text or as personal communication. The *Canadian Journal of Fisheries and Aquatic Science* allows the use of MSc and PhD theses, while *Fisheries Research* only permits the use of PhD theses. Both allow the use of personal communication and unpublished data must be cited in the text but not in the reference list (Table 2 on the appendix).

Journals that are not specific on the use of grey literature (Table 2) revealed that even if it is possible to include MSc theses, technical reports and proceedings, these appeared very rarely, however PhD theses were widely cited.

As shown in Table 1, if grey literature was excluded from the study of the trophic relationships in small pelagics in the Gulf of California, it would represent a loss of 67.3% of the whole information of species related to this group. Elasmobranchii would be the most affected group because only three out of 13 references are white literature and thus can be reported in a journal that rejects grey literature. Information on bonny fish and marine birds would also be reduced considerably. For each group, only two out of ten references can be reported as white literature. Cephalopods and marine mammals are the less affected group since most of the reports are referred in indexed journals (Fig. 1).

Because some journals allow the use of MSc theses in the references, we also analyzed the database considering only white literature and MSc thesis. We observed a considerable increase of information that can be included especially in the taxa of elasmobranchii and marine birds (Fig. 1)

DISCUSSION

This study revealed that, although there is a tendency to avoid the use of grey literature in scientific publications (Wilbur, 1990; Lacanilao, 1997), these sources of information may give more detailed data than that found in peer reviewed articles, as illustrated in specific aspects of the trophic ecology of small pelagics in the Gulf of California.

As seen in table 1 and figure 1, by disregarding MSc thesis, technical reports and proceedings, there can be a potential loss of valuable information concerning the importance of the small pelagic as part of the diet of several species of fishes, elasmobranchii, marine mammals and birds in the Gulf of California. This situation may gain momentum at the time

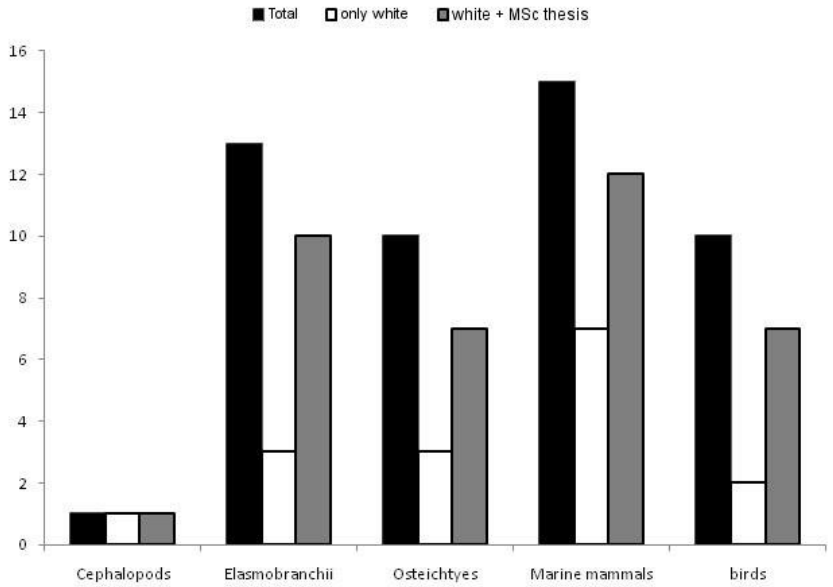

Figure 1. Number of references for each taxa reported in literature: Total; considering only white literature; and considering white literature and MSc theses

of integrating ecological information for the development of management strategies for small pelagics (see for example Velarde *et al*., 2004).

In our evaluation, more than half of the information gathered came from postgraduate theses, mainly MSc. However, the results obtained in these theses could not be found published in journals in ISI or the Google Scholar search engine. This supports the idea described by Lacanilao (1997) and Sáenz-Osuna (2009) that information gathered by graduate dissertations in developing countries are seldom transferred to peer reviewed journals.

This highlights the need that institutions have to produce grey literature and to encourage their staff to prepare the results of their investigations in journal publications. Institutions should also instruct their researchers (authors) about the quality and ethical standards of the journals (Wilbur, 1990) if the main objective is the generation of more useful information and its publication among the scientific community.

CONCLUSIONS

This study shows that grey literature is a useful tool in the scientific work because it contains data that may not be available in commercial scientific journals, giving a wider perspective of the research of our choosing as well as the hypothesis testing process. Important efforts should be placed to increase efforts to publish grey literature in order to avoid the loss of substantial amounts of information due to its inaccessibility.

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APPENDIX

Table 1. Bibliographic review of the importance (as percentage) of small pelagic fishes in the diet of predators in the Gulf of California, including reported sampled area (southern=S, center=C, eastern=E, western=W, and entire Gulf of California=GOC), period and relevant observations. References to peer reviewed journal articles are marked in bold, and grey literature classified as: [1] Graduate thesis (BSc); [2] Master degree thesis; [3] Doctoral degree thesis; [4]Technical reports; and [5]Abstracts.

Predator	Area	Period	%	Prey	Observations	Bibliography
Cephalopods						
Jumbo squid (*Dosidicus gigas*)	CS	1995-2000	< 0.3	Clupeidae +Engraulidae (Herrings, Sardines and Anchovies)	%IRR	Markaida *et al*., 2003; Markaida., 2006
	CSW	2002-2003	26	Engraulidae (Anchovies)	%IRR	Armendáriz-Villegas, 2005[1]
Elasmobranchii						
Scalloped hammerhead	SE	2000-2004	0.31	*S. caeruleus* (Pacific sardine)	%IRR	Torres-Rojas *et al*., 2006
(*Sphyrna lewini*)			0.25	Engraulidae		
Juvenile scalloped hammerhead *(Sphyrna lewini)*	CSW	2001-2002	2.52	*S. caeruleus*	%IRR	Aguilar Castro, 2004[2]
			9.49	*Scomber japonicus* (Chub Mackarel)		
Juvenile scalloped Hammerhead *(Sphyrna lewini)*	S	El Niño 97-98	1.1	*Ophistonema libertate* (Pacific thread herring)	%IRR	Torres-Huerta, 2004[2]
Scalloped hammerhead *(Sphyrna zygaena)*	SW	2000-2004	2.96	*S. caeruleus*	%IRR	Ochoa-Díaz, 2006[1]
Scalloped hammerhead *(Sphyrna* sp.)	SW	1981-1982		—	Small pelagic fishes were not identified in stomach contents	Galvan-Magaña *et al*., 1989
Pacific sharpnose shark (*Rhizoprionodon longurio*)	S	2003-2004	24.1	*Opisthopterus dovii* (Longfinherring)	%IRR	Conde-Moreno, 2009[2]
Whale shark (*Rhincodon typus*)	W	1995-2005	—	—	no report of predation on small pelagic fishes	Ketchum, 2003[2]; Hacohen, 2007[2]
Smooth hound shark (*Mustelus californicus*)	N	2002	1.7	*Cetengraulis mysticetus* (Pacific anchoveta)	%IRR	Mendez-Loesa, 2004[1]
Smooth hound shark (*Mustelus californicus*)	SW	1981-1982	—	—	Small pelagic fishes were not identified in stomach contents	Galvan-Magaña *et al*., 1989
Smooth hound shark (*Mustelus californicus*)	N	2002	0.12	*C. Mysticetus*	%IRR	Mendez-Loesa, 2004[1]
Silky shark *(Carcharinus falciformis)*	S	1992-1994	0.46	*S. caeruleus*	%IRR	Andrade, 2005[2]
Smooth-tail mobula *(Mobula* sp.*)* Pacific angel shark *(Squatina californica)*	SW	2002-2007	—	—	no report of predation on small pelagic fishes	Sampson, 2007[2]
	S	2000-2003	0.03	*S. caeruleus*	%IRR	Escobar-Sánchez, 2004[2]
			4.23	*Etrumeus teres* (Round herring)		Escobar-Sánchez *et al*., 2006
Osteichthyes						
Ocean whitefish (*Caulolatilus princeps*)	SW	1986-1987	<5	Clupeidae	%IRR	Caraveo, 1991[1]
Yellow snapper (*Lutjanus argentiventris*)	SW	2003	23.7	*Harengula thrissina* (Pacific Flaitron herring)	%IRR	Vázquez-Sánchez, 2008

Table 1. Continued.

Predator	Area	Period	%	Prey	Observations	Bibliography
Common dolphinfish (*Coryphaena hippurus*)	S	1990-1991	0.2	*S. caeruleus*	%IRR	Aguilar-Palomino, 1993[2]
			1.2	*S. japonicus*		Aguilar-Palomino *et al*., 1998
	S	2000-2003	0.02	Clupeidae	%IRR	Tripp-Valdéz, 2005[2]
			0.22	*H. thrissina*		
			0.03	*Ophistonema sp*		
			0.05	*S. caeruleus*		
			0.17	Engraulidae		
			0.01	*Anchoa sp*		
			0.06	*S. japonicus*		
	SW	2000-2001	42.43	*H. thrissina*	%IRR	Velasco, 2003[1]
			0.01	*S. japonicus*		
Leopard grouper *(Mycteroperca rosacea*)	SW	1991	34	*H. thrissina*	%IRR	Peláez-Mendoza, 1997[1]
			6.18	*Clupeidae*		
			0.67	*Engraulidae*		
Totoaba macdonaldi	N	1986-1989	30.9	*C. Mysticetus*	%IRR	Román-Rodríguez, 1990
Sail fish (*Istiophorus platypterus*)	SE	2002-2003	0.01	*S. caeruleus*	%IRR	Arizmendi-Rodríguez, 2004[2]; Arizmendi-Rodríguez *et al*., 2006
			3	*Ophistonema sp.*		
			0.41	*O. libertate*		
			0.15	*E. mordax*		
			0.41	*S. japonicus*		
Striped marlin (*Tetrapturus audax*)	SW	1988-1989	23.17	*S. caeruleus*	%IRR	Abitia-Cárdenas, 1992[2]
			0.24	*O, libertate*		
			5.32	*E. teres*		
			1.65	*Clupeidae*		
			43.66	*S. japonicus*		
Blue marlin (*Makaira mazara*)	SW	1988-1989	0.14	*S. caeruleus*	%IRR	Abitia-Cárdenas, 1992[2]
			0.003	*E. teres*		
			0.001	*Clupeidae*		
			0.02	*S. japonicus*		
Marine mammals						
California sea lion (*Zalophus californianus)*	SW	1980-1993	0		% relative abundance	Aurioles-Gamboa *et al*., 2003
	CN	1995-1996	10.16	*S. caeruleus*	%IRR	García-Rodríguez, 1999[2]
			5.96	*E. mordax*		García-Rodríguez & Aurioles-Gamboa, 2004
			1.39	*S. japonicus*		
			1.98	*C. mysticetus*		
			1.47	*Trachurus symetricus* (Jack mackerel)		
	C	1989-1992	—	Clupeidae	Population trends related with sardine trends	Aurioles-Gamboa & García-Rodríguez, 1999[5]; Szteren *et al*., 2006
	GOC	2002	11.78	*C. mysticetus*	Important prey index	Porras-Peters, 2004[2]

Table 1. Continued.

Predator	Area	Period	%	Prey	Observations	Bibliography
California sea lion (*Zalophus californianus)*			5.61	*T. symetricus*		
			5.47	*S. caeruleus*		
			5.35	*E. mordax*		
			2	*E. japonicus*		
Vaquita *(Phocoena sinus)*	N	1967, 1986-1993	27.2	*Anchoa sp.*	%IRR	Fitch & Brownell, 1968; Pérez-Cortez *et al*., 1996
Bryde's whale *(Balaenoptera edeni)*	SW	1988-1995	—		Feed on small pelagic fishes	Urbán & Flores, 1996
	SW	1988-2006	—		Presence related with sardine trends	Salvadeo et al., 2007[5]
Fin whale *(Balaenoptera physalus)*	SW	1988	—		Feed on small pelagic fish and plankton	Gendron, 1993
	SW	1993-1995	—		Feed on plankton	Del Ángel, 1997[2]
	GOC	2001-2002	—	*S. caeruleus*	Isotopic signal during the warm season	Jaume, 2004[2]
Blue whale *(Balaenoptera musculus)*	GOC	1993-2007	—		Feed on plankton	Del Ángel, 1997[2]; Busquets Vass, 2008[2]
Sperm whale *(Physeter macrocephalus)*	GOC	1998-2004	—		Feed on jumbo squid	Jaquet & Gendron, 2002; Davis *et al*., 2007
Pilot whale *(Globicephala macrorhynchus)*	SW	1989-2006			Feed on jumbo squid	Vázquez-Morquecho, 1997 [1]; Salvadeo, 2008[4]
Common dolphin (*Delphinus sp.)*	SW	2003-2006			Feed on small pelagic fishes	Salvadeo, 2008[2]
Bottlenose dolphin *(Tursiops truncatus)*					Feed on fishes and squid	Díaz-Gamboa, 2004[2]; Salinas, 2005[3]
Fish eating cetaceans (*Balaenoptera edeni; Delphinus delphis)*	C	1983-1985			Increased numbers in the Canal de Ballenas during an El Niño event	Tershy *et al*., 1991
Birds Heermann's gull *(Larus heermanni)*	C	1983-1992	33	*S. sagax*	% of total prey	Velarde et al 1994[4]; Velarde *et al*., 2004
			65.3	*E. mordax*	Diet predicted from commercial landins	
Elegant tern *(Sterna elegans)*	C	1983-1992	24	*S. sagax*	% of total prey	Velarde et al 1994[4]; Velarde *et al*., 2004
			70	*E. mordax*	Diet predicted from commercial landings	
			3	*S. japonicus*		
Red-billed tropic bird *(Phaethon aethereus)*	SE	2004-2007	2.3	*O. libertate*	% of total prey	Guevara-Medina, 2008[2]
Royal tern *(Thalasseus maximus)*	SE	2007	29	*Anchoa sp.*	% of total prey	Angulo-Gastélum, 2008[2]
			20	*C mysticetus*		
Brown booby *(Sula leucogaster)*	C	1998-2000	2.4	*O. libertate*	% of total prey	Mellink *et al*., 2001
			1	*Lile stolifera*	San Jorge island	
			3.4	Clupeidae		
			6.6	*S. japonicus*		
			10.2	*Anchoa sp.*		

Table 1. Continued.

Predator	Area	Period	%	Prey	Observations	Bibliography
Brown booby *(Sula leucogaster)*			44	*C. mysticetus*		
	C	1999-2000	5.6	Clupeidae	% of total prey	Mellink *et al*., 2001
			18	*Anchoa sp.*	San Idelfonso and San Pedro Martir island	
			49	*C. mysticetus*		
			15	*S. japonicus*		
Blue booby *(Sula nebouxii)*	C	2003	64	*O. libertate*	Regurgitated frequency	Castillo-Guerrero, 2003[2]
			2	*Anchoa exigua*		
			13	*C. mysticetus*		
Brown booby *(Sula leucogaster)*	C	2003-2004	27.4	*S. caeruleus*	% of total prey	Suazo-Guillén, 2004[2]
			2.2	*Leuresthes sardina*		
			1.1	*O. libertate*		
			0.6	*E. teres*		
			20.6	*C. Mysticetus*		
			30.9	*Anchoa sp*		
Brown pelican *(Pelecanus occidentalis)*	SW	1984-1986	2.8	*H. thrissina*	Regurgitated frequency	Jiménez-Castro, 1988[1]
			1.95	*O. libértate*		
			15	*Anchoa ischana*		
			42	*S. japonicus*		
Marine birds *(S. nebouxii; S. leucogaster)*	C	1983-1985			Increased numbers in the Canal de Ballenas during an El Niño event	Tershy *et al*., 1991

Table 2. List of Peer review journals with their ISSN, impact factor and their policy on grey literature

Journal	Impact Factor (2008)	Policy on grey literature
Fish and Fisheries	3.158	Not allowed
Fisheries Oceanography	2.812	Not allowed
Reviews in Fisheries Science	2.375	Not allowed
Canadian Journal of Fisheries and Aquatic Sciences	2.276	Only MSc and PhD thesis allowed
Reviews in Fish Biology and Fisheries	1.792	Not Specified
Fisheries	1.712	Not Specified
Ices Journal of Marine Science	1.661	Not allowed
Transactions of the American Fisheries Society	1.569	Not allowed
Marine and Freshwater Research	1.5	Not allowed
Fisheries Research	1.434	BSc & MSc thesis not allowed
Fisheries Management and Ecology	1.404	Not Specified
Journal of Fish Biology	1.246	Not allowed
Fishery Bulletin	1.19	Not Specified
California Cooperative Oceanic Fisheries Investigations Reports	1.091	Not Specified
North American Journal of Fisheries Management	0.811	Not allowed
Fisheries Science	0.781	Only PhD thesis allowed
Journal of Applied Ichthyology	0.638	Not Specified