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Review

A review and analysis of Easter Island's traditional and artisan fisheries

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ABSTRACT. Based on a review of published and unpublished reports we analyzed Rapa Nui´s (Easter Island) traditional and artisan fisheries. We include information from 2000-2009 on landings, species, fishing grounds, fleet and number of fisherfolks according to the Servicio Nacional de Pesca (SERNAPESCA) and personal communication with SERNAPESCA officials. Presently, 29 species of fishes and two invertebrates are fished (along with a group of species reported as "non-identified"), primarily from the 10 main fishing grounds within 5 nm from the shore. Sporadic fishing trips reach areas up to 25 nm offshore. Statistics about the artisan fleet and number of operative fishers is spotty and unreliable. In 2011 SERNAPESCA reported 123 artisan fishers and 31 boats for the island. Landings occur in five coves, of which Hanga Piko and Hanga Roa are the most important. Between 2000-2009 the mean annual landing ranged between 109-171 ton. The main exploited resources during this period were yellowfin tuna, snoek, Pacific rudderfin, rainbow runner, glasseye, oilfish, deep-water jack and swordfish. We highlight the urgent need to improve fisheries statistics (catch, effort, fishing grounds) in order to develop a science-fishery management and conservation plan, particularly linked with artisan fishery activities. Globally, we identify the need to integrate across fields (*i.e.*, ecology, conservation, fisheries, education, outreach) more broadly in the national research system, to improve the management and conservation of Easter Island's unique marine environment. Within this framework, we identify an urgent need to create a research marine station on the island with permanent personnel, which can focus on this fragile oligotrophic ecosystem.

Keywords: Easter Island, artisan fishery, marine resources, fishing grounds, fleet, fisher folks, tropical southeastern Pacific.

Revisión y análisis de las pesquerías tradicionales y artesanales de Isla de Pascua

RESUMEN. Se realiza una revisión de la pesca tradicional y artesanal en Isla de Pascua, basada en la literatura publicada y no publicada. Se incluye información (2000-2009) de los desembarques pesqueros, especies, sitios de pesca, flota y número de pescadores, según el Servicio Nacional de Pesca (SERNAPESCA) y comunicación personal con sus funcionarios. En la isla se extraen 29 especies de peces y dos de invertebrados (un grupo de especies en la estadística es informada como no identificada), principalmente en 10 sitios en las primeras 5 mn de costa. Esporádicamente se realiza pesca en alta mar hasta las 25 mn. Las estadísticas sobre la flota artesanal y los números de pescadores son poco confiables. En el 2011 SERNAPESCA, indica la existencia de 123 pescadores artesanales y 31 embarcaciones menores. Los desembarques ocurren en cinco caletas, siendo las principales Hanga Roa y Hanga Piko. Durante el período 2000-2009 el desembarque pesquero fluctuó entre 109-171 ton. Los principales recursos pesqueros son el atún aleta amarilla, sierra, nanue, vidriola, ojo de vidrio, bacalao, jurelillo y pez espada. El ecosistema marino de Isla de Pascua es único y existen necesidades urgentes. En lo pesquero, es necesario mejorar las estadísticas pesqueras (captura, esfuerzo, áreas de pesca) para desarrollar un plan de manejo científico-pesquero artesanal y de conservación. Globalmente, es imperativo integrar científicamente, en todos los ámbitos de investigación, a Isla de Pascua al sistema de investigación nacional. Se podría avanzar en esta dirección creando una Estación de Investigación Marina en la isla, adecuadamente equipada y con personal permanente, que pudiera enfocar esfuerzos en el frágil ecosistema oligotrófico que rodea la isla.

Palabras clave: Isla de Pascua, pesca artesanal, recursos marinos, áreas de pesca, pescadores, Pacífico tropical suroriental.

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INTRODUCTION

Rapa Nui (Big Rapa, Big Land), Mataki ki te rangi (Eyes that look the sky), Te Pito O Te Henua (Belly button of the world), Hititeairagi, Davis Island, Isla San Carlos (1770), Teapi, Vaihu (names used by J. Cook), "Paasers", Easter Island or Isla de Pascua, are some of the names given by sailors, filibusters, explorers, writers, viceroys, governments and Polynesian natives to one of the most isolated habited islands in the world (Chauvet, 1945; Anderson, 1995; Chapman, 1997). Easter Island (163.6 km^2) is a highly isolated island in the tropical southeastern Pacific (Fig. 1). The closest islands are Pitcairn 2,250 km to the west, the Galápagos Archipelago 3,872 km to the northeast, and the Juan Fernandez Archipelago 3,140 km to the east. Easter Island is 3,700 km from continental Chile. The island has a yet unsettled history of early human settlements, probably due to more than one original migration from central eastern Polynesia that occurred between 1000-1200 AD (Chapman, 1997; Green, 1998, 2000; Hunt & Lipo, 2006; also see www.isladepascua.uchile.cl/publicaciones). The original language of islanders is of Polynesian origin (Englert, 1938, 1948). At present, the island has about 4000 inhabitants.

On April 6th, 1772, just before Easter, the Dutch navigator Jakob Roggeveen discovered the island and named it "Paasers". The government of Chile took official possession of Easter Island on September 9th, 1888 (Ibañez, 1978). In 1935 the island was declared as a National Park and Historic Monument and in 1995 UNESCO named it a Cultural Patrimony of Humanity. The official Management Plan for Rapa Nui National Park was drafted in 1997 (CONAF, 1997). So far, comprehensive reviews about the natural history and fisheries of Easter Island have been published by Echeverría & Arana (1978), Castilla (1987) and Arana (2014).

Easter Island has become a paragon of prehistoric human-induced ecological catastrophe and cultural collapse, based on two rather contradictory narratives: a) the effects of population increases and islanders' overexploitation of natural resources (*i.e.*, soil erosion and widespread rapid deforestation of forests dominated by giant *Jubaea* palms) and self-destruction or "ecoside" (Diamond, 1995, 2005, 2007; Rolett & Diamond, 2004); and b) by a synergy of ecological impacts and, particularly, the devastating effects of introduced rats *Rattus exulans* on the island (Hunt, 2007; Hunt & Lipo, 2009). The impact of the exploitation of the ocean has received less attention. In this paper, we provide a short overview of Rapa Nui´s traditional fishery practices and then review, synthesize and analyze the published literature and reports on artisan small-scale fisheries, describing temporal variations in annual resource landings, artisan fishery activities, fleet, fishing areas and fishers in the island, mainly based on Chilean official landings and reports by the Servicio Nacional de Pesca (SERNAPESCA). Finally, we identify main challenges and needs for the scientific integration of Easter Island to Chile and offer suggestions for future research.

MATERIALS AND METHODS

In order to synthesize information on artisan fisheries, we reviewed general fishery and conservation ancestral cultural elements and published literature and reports (grey literature) on Easter Island's traditional, small-scale and subsistence fisheries. Additionally, information about the number of artisan fishers, fleet, coves, fishing areas, species fished and official landing reports were extracted from the Annual Reports (2000-2009) of SERNAPESCA, as reported in the Integrated Information System Planning, Undersecretary of Fisheries and Aquaculture of the Ministry Economy, Chile. Unpublished reports and personal communications from SERNAPESCA officials were also analyzed.

In order to identify the main inshore and offshore fishing zones and the maximum fishing distances from the coast where regular or sporadic fishing trips take place, interviews were conducted between October-December 2012 by the local Pew Global Ocean Legacy team. After previous agreement, ten active fishermen were interviewed and presented with a map centered in the island, with a maritime space of about 50 nm. Fishers were asked to indicate directly on the map the most common fishing areas within the first 5 nm from the coast and more offshore areas, where fishing trips take place sporadically. The information collected was geo-referenced (ArcGIS) and then mapped using geo-referenced maps with layers of the spatial distribution of chlorophyll concentration and sea surface temperature around Easter Island (Andrade *et al.*, 2014a). Unvaried statistical analysis was done before

tests of normality. A linear regression model and a one-way Analysis of Variance (ANOVA) followed by Tukey *post-hoc* test were used.

RESULTS

Fisheries in Easter Island

Short overview of Rapa Nui's traditional fishery practices

Since the early Polynesian colonization of Easter Island, shore hand-gathering and traditional Polynesian fishing trapping, snaring, spearing and netting have been used to gather marine resources for the subsistence of islanders (Metraux, 1940; Englert, 1948, 1974; Mulloy, 1975, 1978; Ayres, 1979; CONAF, 1997; Arana, 2014). Today, there are still well rooted ancestral cultural elements in fishing activities among the islanders. For example, the first catch of a new boat is given to the elderly according to ancestral traditions, since this ensures a good future for the boat (Ramírez, 2010). The artisan fabrication of sophisticated and polished hooks (stone, human bones) is well documented and akin to those made by natives in several Pacific islands, such as the Marquises, New Zealand and Tahiti (Chauvet, 1945; Ayres, 1979). The Rapa Nui's local language also has expressions referring to numerous maritime traditions. For instance, intertidal and shallow hand-gathering of diverse marine species (octopus or heke, small crabs or pikea, sea urchins or hatuke, snails or pipi, and algae) is called komorunu pipi. Women and children primarily carry out these activities for a source of food (Osorio *et al*., 1990a, 1990b) and to obtain marine materials for handicrafts such as necklaces and rings. Littoral night-fishing of the Easter Island lobster or ura (*Panulirus pascuensis*), using torches (branch), is also part of the Rapa Nui's cultural tradition. According to Ramírez (2010) and Yáñez *et al*. (2007) the implementation of new technologies, such as modern flashlights and SCUBA diving equipments, have sped up overex-ploitation and today only a few experienced divers extract lobsters.

Shore-based dive and spear fishing (ruku, rukuruku*)* and netting (tuku kupena*)* are also part of ancient islanders' traditions. Netting is still done in groups and nets are set in sites well known to the Rapa-Nui inhabitants (Hernández & Ramos, 2001; Ayres, 1985, Arana, 2014). Shore-based fishing with a rod (hakaranga*)* or with a manual reel (hi ika) is done mostly for family consumption (Hernández & Ramos, 2001), generally using chicken or bread crumbs as bait. Collective oral memory recounts this way of fishing since the days of the sheep farm of Balfour Williamson & Co. (1895). According to Ramírez (2010), this company forced the natives to work and confined them to an area of about one thousand acres in the town of Hanga Roa (which was enclosed by a stone wall), outside of which natives could not plant, hunt or fish without permission. By the nineteenth century on the island, boat building on the island was impossible, due to the timber shortage, which forced the islanders to exert large fishing pressures on intertidal and shallow-subtidal ecosys-tems. From a marine conservation point of view, there are testimonies showing that advanced sea-care-behavioural attitudes are part of Rapa Nui's culture. For instance, they self-regulate by acknowledging marine species' reproductive periods with a closed fishing season (tapu). Most native islanders have good knowledge about how, where and when to fish. In general, every inhabitant of Rapa Nui has had some experience in coastal or open sailing in association with fishing and even today each Rapa Nui family on the island owns traditional places for the extraction of marine resources (Ramírez, 2010).

Easter Island fisheries, coves, fishing areas, fleet and fishers

Presently, almost all fishing activity in Easter Island is done locally and within the artisan subsector (for definition see Castilla, 2010). The Chilean industrial fleets operates only occasionally around Easter Island and the operation of foreign fleets based at Easter Island is not legally allowed. There are three main shore-based artisan fishery categories: a) intertidal hand-gathering, b) shore-based fishery using line-hooks, nets and free diving, and c) coastal artisan fisheries with boats, including autonomous diving. On Easter Island, the hand-gathering of marine resources collection is mainly of intertidal molluscs, seaweeds and crustaceans from intertidal pools, littoral channels, crevices and emerged shallow subtidal coral formations (Ayres, 1979, 1985; Yáñez *et al*., 2007). The extraction of these organisms (mostly shells) is primarily for the manufacture of artisanal products sold to tourists. This activity is mainly done by women (Osorio *et al*., 1990; AMBAR, 2001; Rivera, 2003). The species most intensively extracted is the marine snail pure, which has led to a significant decline in its abundance (Rivera, 2003). Shore-based fisheries, using line-hooks, nets and free diving is done mainly by men in rocky areas extracting the traditional fish nanue and other rock fish species for local consumption; this also represents a recreational activity (Inostroza, 1978; AMBAR, 2001; Yáñez *et al*., 2007; Randall & Cea, 2011).

On Easter Island there are five artisan fishing coves: Hanga Roa, Hanga Piko, Hotu Iti, Hanga Hoonu and Vaihu (Fig. 1; AMBAR, 2001; Yáñez *et al*., 2007). The most important ones are Hanga Roa and Hanga Piko, on the west side of the island. There are three main

types of coastal fishing activities using artisan boats: a) inner-inshore coastal fishing in shallow inshore waters, b) fishing trips within the first 3-5 nm from the coast (see Fig. 1), and c) offshore sporadic fishing trips, up to 25 nm from the coast. According to Yañez *et al*. (2007) there are 10 main recurrent inshore fishing areas around the island, all of them within 3-5 nm of the coast (also see Inostroza, 1978). The area known as Apolo, at the southern end of the island, has the greatest number of fishing visits (Fig. 1; Yañez *et al*., 2007). The main species extracted in these areas are the yellowfin tuna (*Thunnus albacares*), snoek, (*Thyrsites atun)*, yellowtail jack *(Seriola lalandi)* and the Pacific rudderfish *(Kyphosus sandwicensis)* (Yañez *et al*., 2007; Inostroza, 1978). The depth of fishing areas targeted by the artisan fleet range from the shallow subtidal to about 100 m (Inostroza, 1978; Bahamonde *et al*., 1993; AMBAR, 2001; Yáñez *et al*., 2007) and boats spend 6-11 h per fishing trip. Artisan fishermen sporadically fish in waters further offshore, mainly to target yellowfin tuna, rainbow runner and swordfish. Our interviews showed the current importance of the same 10 main inshore fishing areas reported by Yañez *et al*. (2007), and sporadic offshore fishing trips at distances ranging between 5-25 nm from the coast (Fig. 2). We geo-referenced this information, creating maps with layers of spatial distribution of chlorophyll-*a* concentration and sea surface temperature (Figs. 2a-2b; Andrade *et al*., 2014a). Chlorophyll-*a* is slightly more concentrated around the 7-10 nm perimeter of the island, where most of the fishery occurs, and particularly in the eastern border (Fig. 2a). Sea surface temperature does not show important variations in the area where artisan fishing trips are common (Fig. 2b).

Currently, the Easter Island artisan fishery operates mainly with deckless wooden or fiberglass boats under 10 m in length. However, there are sporadic reports of 1-2 middle-scale fishing vessels in the island (about 14-15 m in length: "lanchas") and occasional fishing trips to Salas y Gómez, 224 nm from Easter Island (Fig. 1). The main fishing gear used includes nets and hand lines made of monofilament nylon thread. The specific characteristic of each line depends on the target species. For example, for the traditional fish, nanue, fishers use monofilament nets of 4-5 mm (Yáñez *et al*., 2007; Inostroza, 1978).

According to the official fishing vessel National Fishery Registry (NFR) between 1995 and 2011, the number of artisan boats on the island has increased from 21 in 1995 to 123 in 2011 (Table 1). Eberhard & Inostroza (1978) reported 66 artisan fishers on the island, and according to the official NFR (1995-2011), the number of fishers has increased from 56 in 1983 to 123 in 2011 (Table 1). Nevertheless, there is no report about the actual number of operative fishers per year on the island, thus, figures refer to the growing number of fishers registered each year by the NFR between 1995-2011 and the 16 fisherwomen operating on Easter Island (SERNAPESCA, 2013). Yáñez *et al*. (2007) indicate that during 2007 just under 50% of the fishers on the island declared that they did not report catches to SERNAPESCA and therefore the official landing statistics from SERNAPESCA may be an underestimation of actual extractions.

Examples of early studies on Easter Island marine resources

Easter Island fishery studies

Inostroza's 1978 study on artisan fishery landings on Easter Island is the first published information about this activity. It includes an estimate of overall catch per unit effort (CPUE) for all fish species extracted by a fleet of 24 artisan wooden boats with lengths of 5-8 m and outboard engines of 12-40 HP using nets. This information, obtained in 1977-1978, was recorded exclusively at Hanga Roa and shows that in 365 days 626 fishing trips were carried out by 24 boats. A total of 32 fished species were reported: 30 fishes and two crustaceans. Overall CPUE, summing across resources, was 21.3 kg 100 m^{-1} of net. The nanue and snoek were the most important species, with 16.4 and 3.8 kg 100 m^{-1} of net respectively. For offshore fishing operations, an average of 28.1 kg day^{-1} was estimated, mostly yellowfin tuna (14.9 kg day^{-1}). Inostroza (1978) emphasized that these estimates should be taken with caution, since, for instance, the reported 1,774 kg landing of yellowfin tuna corresponded just to five large individuals. With respect to the lobster fishery, the study showed a capture of 1.5 lobster $trap^{-1}$. The study concluded that the fishing effort of Easter Island's artisan fleet was limited and lacked continuity (Inostroza, 1978). The fishery report of IFOP (1984) provided additional information on the main fishery activities on the island and although it did not include data on landings, pointed out that landings have markedly decreased in relation to those reported by Inostroza (1978).

Ura (*Panulirus pascuensis):* the Easter Island lobster

Historically, earlier fishery reports for this fishery in Easter Island are: a) John Lengerich (1953) who visited the island on a fishing mission in the vessel Angamos, and b) Edwin Reed (1954) who identified the species *Panulirus pascuensis* (Reed, 1954). Lengerich (1953) evaluated the island lobster fishery potential (Henríquez, 1974). This author compared morphometric variables and CPUE of Easter Island lobster, using data

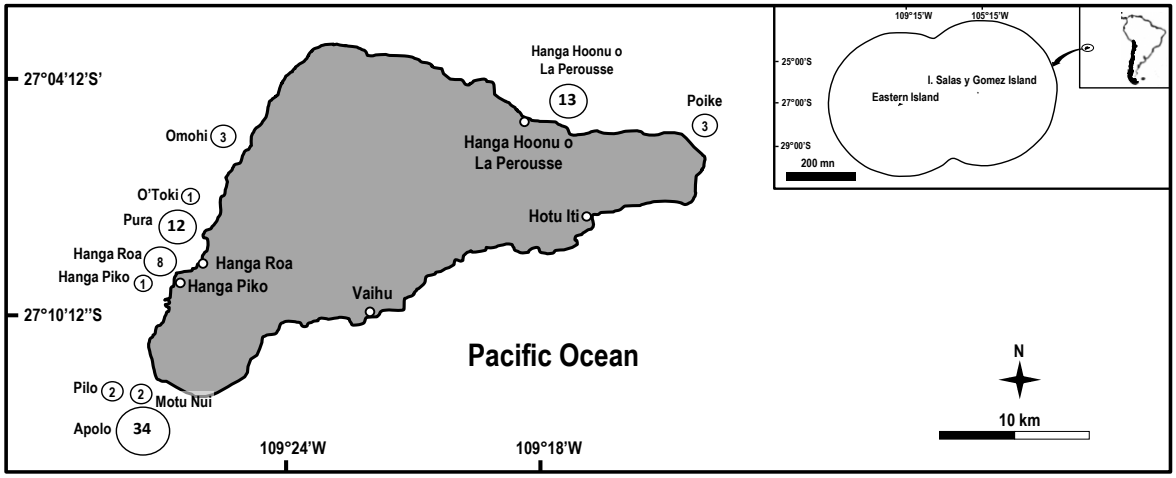

Figure 1. Easter Island and Salas and Gómez Island, as part of Chilean oceanic islands, circled by 200 nm (insert). For Easter Island the 5 main artisan coves and the 10 main inner inshore (<5 nm from the coast) fishing grounds used by artisan fisher are shown. Numbers inside the circles indicate the times that the fishing ground was mentioned by the 37 interviewed fishers. Main species mentioned to be fished in those grounds were yellowfin tuna, snoek, yellowtail jack and Pacific rudderfish (redrawed from Yañez *et al*., 2007).

collected from 1953 (by Lengerich,1953) to 1974. His work concluded that CPUE did not change significantly over 21 years, but detrimental changes were seen in the size distribution through time. Furthermore, Inostroza (1979) analyzed historical data on the carapace length of the Easter Island lobster, based on reports by Lengerich (1953), Henríquez (1974), Eberhard *et al*. (1976), and Inostroza (1978). This analysis showed that between 1953 and 1978 the average size of the fished lobster decreased from a cephalothorax maximum length of 94.7 to 140.7 mm. In 1970 regular Chilean commercial air flights between continental Chile and Easter Island began along with shipments of Easter Island lobster to continental Chile. According to Henríquez (1974) these shipments amounted to around 800-1200 kg of lobster per month. The operation ended in 1972, when authorities implemented the first regulation to protect lobsters, prohibiting their shipment to the continent, therefore restricting the lobster market to the island. Nowadays, there are further fishery regulations for this species, including restrictions for extraction, marketing and transportation (DS 209/1979), with a temporal fishing ban from November 1st to March 1st. Only males can be extracted with a minimum carapace length of 100 mm. The extraction of lobsters is exclusively for domestic consumption of the islanders and tourists can carry only two individuals from the island. Diving, fishing nets, hooks, harpoons, knives or similar gears are prohibited and lobsters can only be captured manually or with traps. According to SERNAPESCA, lobster extraction is currently done by no more than five fishers. The species is extracted daily, preferably using traps, but also occasionally by diving at night using torches or flaslights (Henríquez, 1974; Inostroza, 1979; Castilla & Rozbaczylo, 1987; Yáñez *et al*., 2007). According to Yáñez *et al*. (2007), the extraction of lobsters on the island is continuous throughout the year, despite the temporary fishing ban. The species has a high commercial value (Arana & Vega, 2000). The study of lobster fishing in the Pacific islands shows a serious lack of biological and fishery information, particularly for the Easter Island lobster (Adams & Dalzell, 1993).

Fishery explorations and potential for tuna species

During the 80's and 90's there has been at least one Japan-Chile official fishery and two national explorations into oceanic waters in and around Easter Island. They focused on fishery potential in general and particularly on tuna species very much related to artisan fishery activities. In 1979 the Japan Fishery Resource Research Center (JAMARC), in conjunction with the Chilean Government, carried out a tuna long-line fishing investigation inside the Chilean 200 miles EEZ and Easter Island adjacent waters, focusing on tuna and billfish species (Ichikawa *et al.,* 1980). Basic information on oceanographic conditions, catches, relative abundance and species length frequency composition were reported. In the Easter Island 200 EEZ (= called "Fishing B Ground") information was shown on catch distributions and size frequency for bigeye and yellowfin tunas and for stripped and shortbill

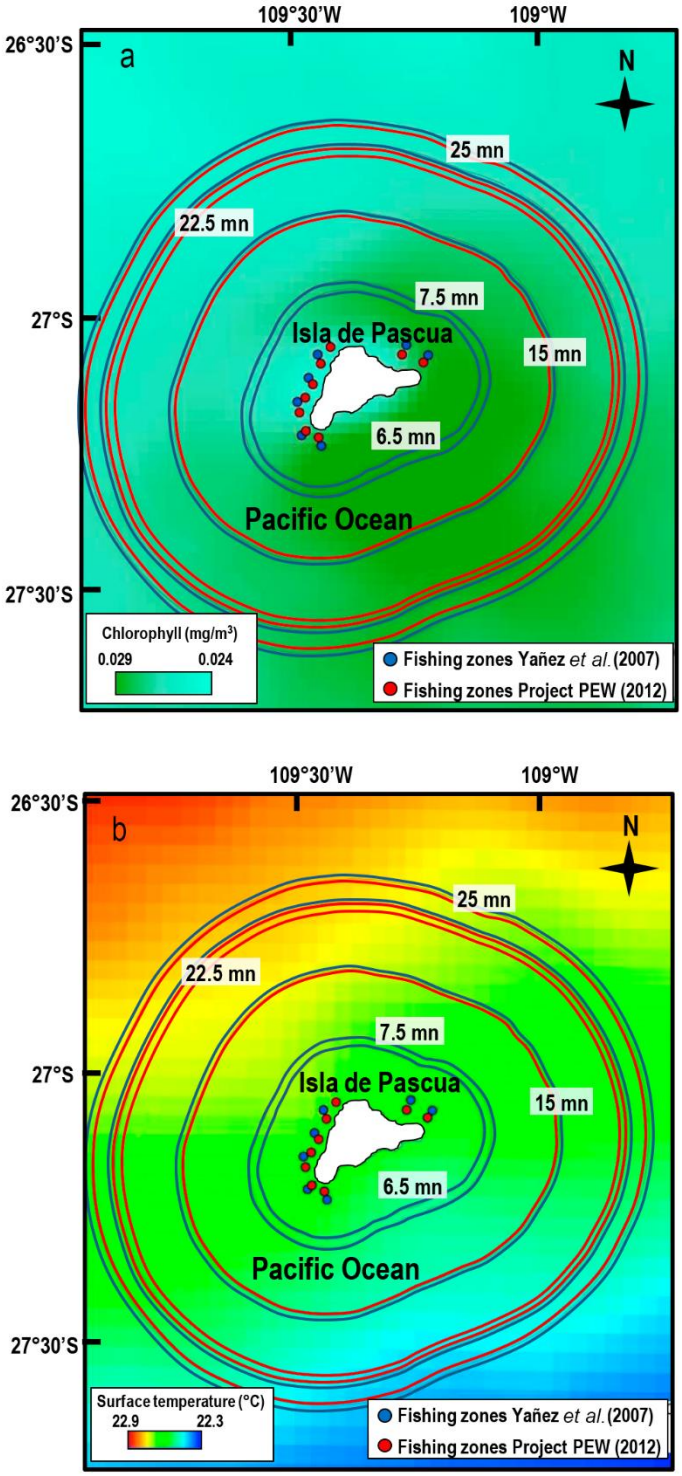

Figure 2. a) Easter Island chlorophyll-*a* concentration, b) sea water surface temperature (from Andrade *et al*., 2014a). Blue (Yañez *et al*. 2004) and red dots (this paper) indicate most common fishing grounds within 5 nm. Blue (Yañez *et al*. 2004) and red circles (this paper) indicate offshore fishing areas sporadically visited by artisan fleet.

marlins. Between October 1992 and May 1993 a fishery research exploration centered on Easter Island in the Maiko Maru 21 (43 m; Bahamonde *et al*., 1993) captured mostly yellowfin, longfin and bigeye tunas and billfins, rendering 1500-2000 kg frozen product per day of operation. It was concluded that longliners of 30-

Table 1. Number of artisan fisherfolks and boats in Easter Island according to available reports. (*) According to Eberhard & Inostroza (1978) only 50% of them were operative. (**) Communication by Sistema Integral de Información y Atención Ciudadana (SIAC), SERNAPESCA, Andrea Gallardo Sepúlveda, Registro Pesquero Artesanal, Dpto. SIEP, Servicio Nacional de Pesca y Acuicultura, Dirección Nacional. RNFR: Registered in National Fisheries Registry.

Year	Number of fisher folks (*)	Number of boats	Reference
1967	-	1	Inostroza (1979)
1974	-	19	González & Eberhard (1974)
1975	30	19	Wurmann *et al.* (1975)
1978	66(*)	-	Eberhard & Inostroza (1978)
1979	-	26	Inostroza (1979)
1983	56	-	Yáñez *et al*. (2007) (boats registered when small-scale artisanal organization started)
2001	21(**)	4	RNFR
2008	60(**)	8	RNFR
2011	123(**)	31	RNFR

60 m were the ideal fleet to exploit theses resources, but that Easter Island did not have port facilities to serve such a fleet. Nevertheless, it was argued that small-scale fishery activities, based on the above resources, could still be developed on the island and that the main challenge was to develop the chain of comercialization. In 1994 the Sociedad Agrícola y Servicios Isla de Pascua Ltda (SASIPA, 1994) further investigated the potential to develop fisheries near Easter Island, mainly via joint-venture approaches and incorporation of the local artisan fleet. The economic evaluation concluded that three long-line vessels would be needed (total annual capture of *ca.* 1000 ton), plus the incorporation of the artisan fleet with captures of approximately 500 kg of tuna species per month, to transform the project into one with low risk investment. In spite of earlier fishery studies, evaluations and projects, no serious effort has been made in Easter Island to develop fisheries to date, and even less so to incorporate artisan fishery activities into duly organized commercial activity.

Small-scale artisan fisheries on Easter Island

A database for 2000-2009

The database of annual landings from SERNAPESCA (2000-2009) includes a total of 32 species: 29 fishes, two invertebrates, one macroalga and an item called "species not identified". The "species not identified" account for approximately 8% of the total landing. We analyzed the geographic ranges of the 29 fishes reported by SERNAPESCA against Randall & Cea (2011) and a global database for fish distributions. From the original list of common names reported by SERNAPESCA, we identified eight fish that do not occur in the biogeographic province of Easter Island (Randall & Cea, 2011; see Table 2). We conclude that these species were probably wrongly identified or that the matching of common names in Easter Island and those used by SERNAPESCA need to be clarified, namely: congrio colorado (*Genypterus chilensis*), lisa (*Mugil cephalus*), pejegallo (*Callorhinchus callorhynchus*), pejerrey de mar (*Odontestes regia*), reineta (*Brama australis*), salmón rey (*Oncorhynchus tshawytscha*), canque (*Stellifer minor*) and the kelp cochayuyo (*Durvillaea antarctica)*. According to SERNAPESCA, over the 10 years of landing hereby analyzed, this group of eight species accounted for less than 1% of the total landing. No geo-referencing for fishing areas is available in SERNAPESCA landings data.

Landings are sorted by cove: Hanga Roa and Hanga Piko comprise about 70% of the artisan landings. There is no official SERNAPESCA information for intertidal or subtidal marine organisms extracted by food-gathers (Ramírez, 2010; Yañez *et al*., 2007). Until 2012 the Chilean Law of Fisheries and Aquaculture of 1991 (Nº18,892) indicated that the Artisan Fishery Registries for Easter Island's fleet and fishers were under the Valparaiso V Region jurisdiction. Nevertheless, modifications to that law in 2002 (Section 48) established the following: Insert, in the second paragraph of Article 50 A, following the full stop (.), the following sentence: "In the case of Easter Island, the Artisanal Registry will be independent of the V Region of Valparaíso". From 2013 on the Easter Island artisan fishery registries will be independent from Valparaíso and may represent a breakthrough to promote a better statistical record of the island's artisan fisheries.

Fishery landings

Annual fishery landings (2000-2009) on Easter Island range between 109 and 171 ton yr^{-1} (Fig. 3). An exception was observed in 2002, when the landing reported was less

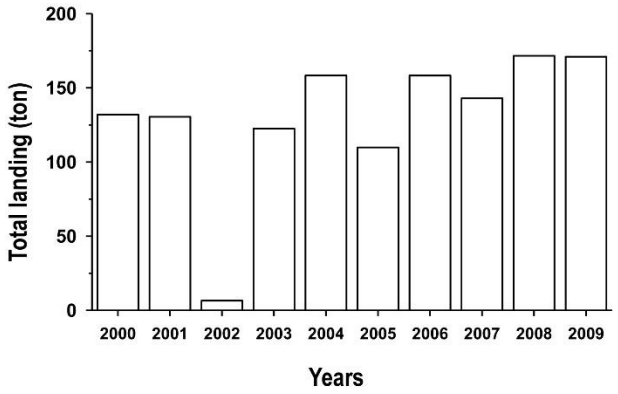

Figure 3. Total landing for in Easter Island fishery between 2000-2009 (SERNAPESCA, 2013).

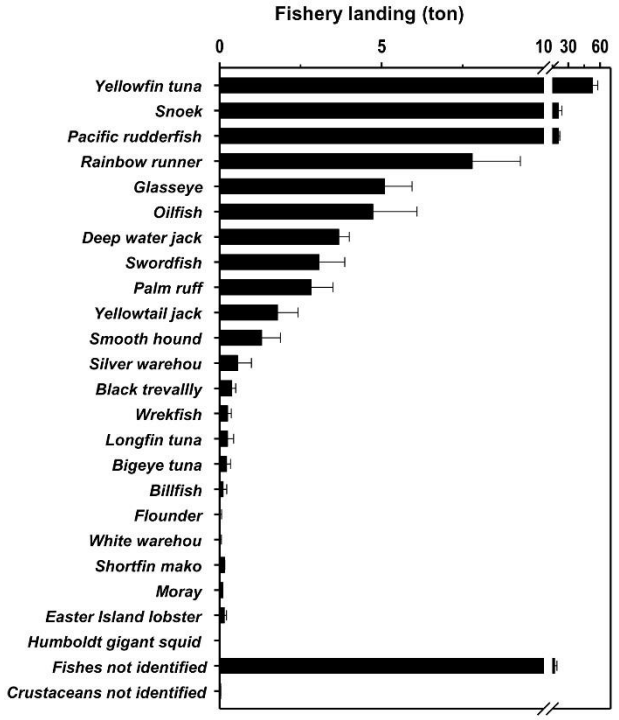

Figure 4. Landing by species between 2000-2009 for the Easter Island fishery (excluding 2002) (SERNAPESCA, 2013).

than 10 ton. Since there is not additional evidence to justify this ten-fold decrease, it was not considered in our analysis. Of the 32 species registered by SERNAPESCA as landed in the island, five fish species accounted for over 80% of the total landing, with average landings of 5-53 ton yr^{-1} (Fig. 4; excluding 2002). The yellowfin tuna is the main exploited species, reaching average landings of 53 ton yr^{-1} and represents on average 41% of total landing in the island. In the 10 years analyzed for the island its total landing amounted to 1,293 ton. The yellowfin tuna, snoek, Pacific rudderfish, rainbow runner, glasseye, oilfish, deep water jack, swordfish, palm ruff, yellowtail jack and smooth hound were the top 10 fished species (Fig. 4). Nevertheless, "species not identified" represented the fourth most important landing item, signaling the weaknesses of the database (Fig. 4).

With *ca*. 50 ton yr^{-1} (±5 ton) each, the coves Hanga Roa and Hanga Piko constituted 70-80% of total landings while the average landing in Vaihu, Hotuiti and La Perouse coves represented about 20-30% of the total landing (Fig. 5a). Hanga Piko cove showed a significant increase in annual landings, gaining dominance over the traditional Hanga Roa. For Hanga Piko, the linear model between annual landing and year estimated increases of 5.7 ton yr^{-1} ($R^2 = 0.54$; analysis of variance model: $F_{1,7} = 9.04$, $P = 0.020$; Fig 5a). For Hanga Roa a decrease of 4.1 ton yr^{-1} in landings was observed ($R^2 = 0.68$, $F_{1,7} = 14.85$, $P = 0.006$; Fig. 5a). For the spatial (coves) and temporal (year) analyses of exploited species on Easter Island, we considered five major species: yellowfin tuna, Pacific rudderfish, yellowtail jack, snoek and swordfish. For the five species we found significant differences on average landing between the five coves (ANOVA; $F_{4,36} = 24.25$, $P < 0.0001$). Landing is significantly different in Hanga Roa and Hanga Piko from the other three coves (Tukey, $P < 0.0001$) (Fig. 5b). Hanga Roa and Hanga Piko showed the highest landings, and there is no significant difference among them (Tukey, $P = 0.26$). The temporal dynamics in the landings showed that the yellowfin tuna experienced a systematic (but not significant) decrease between 2000 and 2009 of about 2.4 ton yr^{-1} (Fig 5b). An increase in landings (non significant) was observed for the snoek.

DISCUSSION

In the traditional and artisan fisheries of Easter Island old Rapa Nui's fishery and conservation practices still co-occur with modern fishery procedures and legislation. In Rapa Nui, the number of fishers and the fleet has increased over the last decade but unsophisticated fishing gear is still used. The island lacks a port and artisan fisheries appear poorly developed (Yáñez *et al*., 2007). Undoubtedly, this has hindered the development of a more productive small-scale fleet and the operation of a middle-scale fleet on the island. According to Yáñez *et al*. (2007) and this study, fishers on Easter Island claim to fish in a small number of inshore fishing areas, within 3-5 nm of the coast. According to Chilean law these fishing areas are within the 5 nm of exclusive access for artisan small-scale fishers (Castilla, 2010). Nevertheless, sporadically fishery trips occur further offshore, up to 15-25

Table 2. List of common names in English, Spanish and Rapa Nui for marine species landed by the artisanal fleet in the five coves of Easter Island (2000-2009), according to SERNAPESCA (Fisheries Sector Indicators - Integrated Land Information System). Common names in English and Spanish and scientific names are according to SERNAPESCA (2013), Inostroza (1978), Randall & Cea (2011). Rapa Nui´s names are according to Englert (1948), Inostroza, (1978) and Randall & Cea (2011). **(*)** No listed in Randall & Cea (2011).

Common names in English and (Spanish)	Rapa Nui name	Scientific name
Swordfish (Albacora, Pez espada)	Ivi heheu, Haura	*Xiphias gladius*
Moray (Murena, Anguila)	Koreha	*Gymnothorax* sp.
Yellowfin tuna (Atún aleta amarilla)	Kahi ave ave	*Thunnus albacares*
Longfin tuna (Atún aleta larga)	Kahi	*Thunnus alalunga*
Bigeye tuna (Atún ojos grandes)	Kahi mata mata	*Thunnus obesus*
Wrekfish (Bacalao)	Kopuku haharoa	*Polyprion oxygeneios*
Silver warehou (Cojinoba moteada)	Piafne	*Seriolella punctata* (*)
Palm ruff (Cojinoba del norte)	Piafne	*Seriolella violacea* (*)
White warehou (Cojinoba del sur)	Piafne	*Seriolella caerulea* (*)
Oilfish (Pez diablo)	Konso	*Ruvettus pretiosus*
Flounder (Lenguado)	Rahai	Bothidae, Soleidae
Billfish (Marlín)		*Tetrapturus* (*); *Istiophorus; Makaira*
Glasseye (Ojo de vidrio,	Mata uira	*Heteropriacanthus cruentus*
Pacific rudderfish (Cabrilla, Escorpión, Nanue)	Nanue, Nanue para Nohu	*Kyphosus sandwicensis*
Deep water jack (Jurelillo)	Po´ opo´ o	*Carangoides equula*
Rainbow runner (Vidriola)	Remo remo	*Elagatis bipinnulata*
Black trevally (Hediondo, Vieja)	Ruhi	*Caranx lugubris*
Snoek (Sierra)		*Thyrsites atun*
Shortfin mako (Tiburón marrajo)		*Isurus oxyrinchus*
Smooth hound (Tollo)		*Mustulos mento* (*)
Yellowtail jack (Toremo, Palometa)	Toremo	*Seriola lalandi*
Easter Island lobster (Langosta de Isla de Pascua)	Ura	*Panulirus pascuensis*
Humboldt gigant squid (Jibia, Calamar rojo)		*Dosidicus gigas*
Species not identified (2)		

nm from the coast. In spite of the small-scale character of Rapa Nui's artisan fisheries (with landing below 200 ton yr^{-1}) some of the fisheries appear to show signs of overexploitation, though no comprehensive and scientifically based study has been done.

Compared with small-scale fishery coves on continental Chile, artisan fishery operations on Easter Island are low. Overall, central Pacific oceanic waters are notoriously oligotrophic (Fig. 2a; Andrade *et al*., 2014a). Nevertheless, a primary-productivity-island-effect ("island mass effect") has been found for islands in the south tropical Pacific (Dandonneau & Charpy, 1985) and for the Juan Fernández Archipelago with relatively higher amounts of chlorophyll-*a* around the islands than in the surrounding ocean. In the case of Easter Island this is particularly true for the southeastern portion of the Island (Fig. 2a; Andrade *et al*., 2014b). Overall, this approximately aligns with some of the most productive inshore fishing grounds as identified by island fishers (Fig. 1). In future programs for fishery management and conservation these fishing grounds should be recognized as areas historically used by Easter Island artisan fishers. Last but not least, in Easter Island offshore waters there is a lack of control on foreign fishing vessels entering the island's 200 nm EEZ, which may affect migratory marine species that are economically important for islanders, such as yellowfin tuna and swordfish (Donoso *et al*., 2009).

For Easter Island's relevant and traditional fished species, such as yellowfin tuna and the Easter Island lobster, there is some important historical biological-fishery information. Nevertheless, there has been a lack of continuous biological and fishery research efforts on those species. So far, the only reported fishery case showing signs of overexploitation refers to: a) the Easter Island lobster, although that last diagnosis was made more than 30 years ago by Inostroza (1979); and b) the intensively hand-extracted snail pure, which has led to a significant decline in its abundance (Osorio *et al*., 1990a, 1990b; Rivera, 2003). For the remaining resources our analyses suggest that the overall global landings in the island (2000-2009) has remained relatively stable, ranging from 109-171 ton yr^{-1}. Howe-

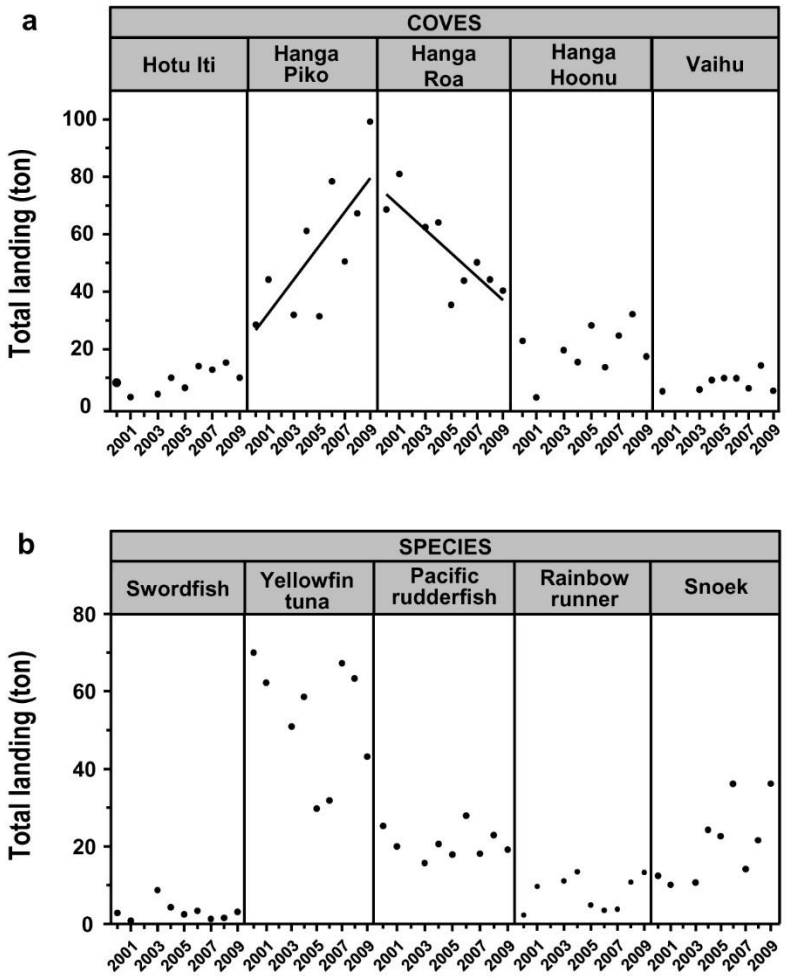

Figure 5. Total landing a) by cove between 2000-2009 for the Easter Island fishery (excluding 2002), b) by species, for the main five species (SERNAPESCA, 2013).

ver, fishery data collection is poor and there appears to be a lack of scientific rigor in the information collected. Additionally, there is a gap in the identification of species landed which might be associated to the lack of data collection protocols and scientifically and technically trained personnel (IFOP, 1984; Yáñez *et al*., 2007). Furthermore, on Easter Island there is a lack of comprehensive and long term fishery-socio-ecological studies, such as those done for other Pacific islands (Johannes, 1978, 1998a, 1998b; Aswani, 1998, 1999, 2005; Johannes *et al*., 2000; Aswani & Lauer, 2006; Cinner & Aswani, 2007). Moreover, there is an almost complete lack of scientific/technological marine research projects that address littoral, coastal inshore and offshore waters in the different branches of oceanography, marine biology, ecology, conservation, fisheries and ecosystem functioning. Castilla (1987) and Castilla & Rozbaczylo (1987) called attention to some of these needs and key research issues, not just for Easter Island, but also for the entire unique set of Chilean oceanic islands (also see Echeverría & Arana, 1978; Arana, 2010). It would appear that more than a few decades are needed for Chilean research funding agencies, authorities and scientists to awake and act accordingly. Chilean oceanic islands are still waiting for that.

Overall, there is an urgent need to develop a comprehensive scientifically based management and conservation plan for the artisan fishing sector in Easter Island in order to promote a series of changes in the current situation. In the past, several studies have been done on Easter Island with regards to the rational development of fisheries and conservation needs (Henríquez, 1974; Wurmann *et al.*, 1975; Inostroza, 1978, 1979; IFOP, 1984; Castilla, 1987; Yañez *et al*., 2007), but no progress has been made to develop a long-term management and conservation plan for marine resources. Thus, we suggest that even if such a long-term plan is developed within the frame of Rapa Nui National park, Easter Island really needs to be

scientifically integrated to Chile in this century. Moreover, we suggest that the only way to achieved such integration will be via the creation of a permanent and well equipped Easter Island Marine Research Station on the island, with enough personnel and a middle sized coastal research vessel. Marine biology, oceanography, fisheries, marine socio-ecological, conservation studies, marine education and outreach should be some of the cornerstone goals for the much needed Easter Island Marine Research Station.

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