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SOCIOECONOMIC IMPACT FOLLOWING THE INTRODUCTION OF THE RED SWAMP CRAYFISH *PROCAMBARUS CLARKII* (GIRARD,1852) IN MOROCCO

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ABSTRACT

The Red swamp Crayfish (*Procambarusclarkii*, Girard, 1852) in developed countries has many ecological, cultural and economic aspects. On the socioeconomic point of view, the impacts of this exotic species are real.

The red swamp crayfish, is a species probably introduced by man in the North-West region of Morocco. The species was introduced for economic reasons, it is currently abundant and widespread in the region. As an invasive species, newly introduced, its exploitation still not regulated by the Moroccan authority. In spite of this and in a voluntary and random way, there is an interesting fishing activity and sale of this species by the fishermen of the region. This activity maintains a considerable source of income and, given the negative impact of this species on biodiversity and the lack of prevention of its spread in the country, this fishing activity may indirectly contribute to limiting the development of the crayfish population to an acceptable level.

This recent study focuses on a new and possible economic resource in the region, estimating the socioeconomic impacts of this species in Morocco as well as the importance of taking into consideration that this has become a new food for Moroccans.

Keywords:

Alien species;
Procambarus clarkia;
Socio-economic;
Morocco.

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1. INTRODUCTION

The introduction of an alien species can be achieved via several pathways [1]. In most cases the introduction is voluntary for an economic purpose, on the other hand the majority of these species can cross borders through accidental pathways such as land, water etc [2]. The introduction of the red swamp crayfish (*Procambarusclarkii*, Girard, 1852), which originates from the southern United States and northern Mexico [3], throughout the world through the growth of international trade is an example. This species is a crustacean that adapts to very diverse environments [4] and has a more selective life cycle than native crayfish [5]. It is largely considered the most invasive of all crayfish species [6]. According to several authors, its spread outside its natural habitat is an ecological error [7] such that its impacts are significant.

Economic analyses of red swamp crayfish on a global scale show that it causes considerable economic and ecological damage but can be a source of revenue if it's exploited. Some countries, such as China [8], take advantage of this to use it as a commercial product. The introduction and spread of this species into the water bodies of many countries has led to the development of fishing activities [9]. Many of the studies, however, are more qualitative than quantitative, due to the relative paucity of data on the economic impact of this species.

The objective of this document is to summarise and update knowledge on the socioeconomics of this invasive alien species and to estimate the real benefits and costs following its introduction in Morocco.

2. MATERIALS AND METHODS

2.1. Study area

Morocco is located in the northwestern of Africa, with an area of 446,300 square kilometers, plus 250 square kilometers of coastal waters. Western Sahara, claimed by Morocco, has an area of about 266,000 square kilometers [10].

Moroccan coasts are fringed in the North by the Mediterranean Sea and the West by the Atlantic Ocean. The continental shelf is characterised by the presence of up-welling, which makes the coastal waters extremely rich in nutritive salts and high biological productivity [11], it has the most extensive river system in North Africa, Its two most important rivers are the Moulouya, which flows into the Mediterranean Sea, and the Sebou, which flows into the Atlantic Ocean [12].

As a result of these water resources, fishing is an important component of Morocco's primary sector [13] which contributes significantly to reducing unemployment and increasing individual annual income.

2.2. Sampling methods

To collect the first information on the sosio-economic impact of the presence of *Procambarusclarkii* in the study area an anonymous survey approved by the Regional Department of Water and Forests and the Fight against Desertification North West Kenitra Morocco in collaboration with the University AbdelmaledEssaadi Faculty of Science Tetouan Morocco was used.

A survey has been distributed to fishermen involved in fishing activity and fish marketing in all areas where the species is present, as well as to farmers affected by this new invasive species, and to the local population. 124 fishermen, 627 farmers and 186 local populations were surveyed in the study area between April 2015 and December 2018 (one field trip per month).

2.3. Statistical analysis

The data collected by the questionnaire concerning the on the economic impact of the presence of Procambarusclarkii required a qualitative analysis using XLStat and Nvivo software.

3. RESULTS AND DISCUSSION

The red swamp crayfish (*Procambarusclarkii*) is recently introduced in Morocco, in irrigation canals, fields of culture, Sebou river, the MerjaFouwarat wetland, the MerjaZerga wetland, the Marais site and the Rmel plateau, the low Loukous wetland, in river systems and wells that are located in the northwestern part of the country [14]. Considering the damage caused by the red swamp crayfish in the rice fields of Morocco [14], and in the absence of a control strategy recommended by the authorities concerned, the question of a possible control by farmers to minimize the damage of this species was crucial. In the area where the red swamp crayfish is present, the question on the nature of its valorisation of the species was also important.

3.1. The red swamp crayfish market

74% of the fishermen questioned replied that the species is fished for consumption and marketing, 26% replied that they do not fish this species because it is not valued in any way (figure 1).

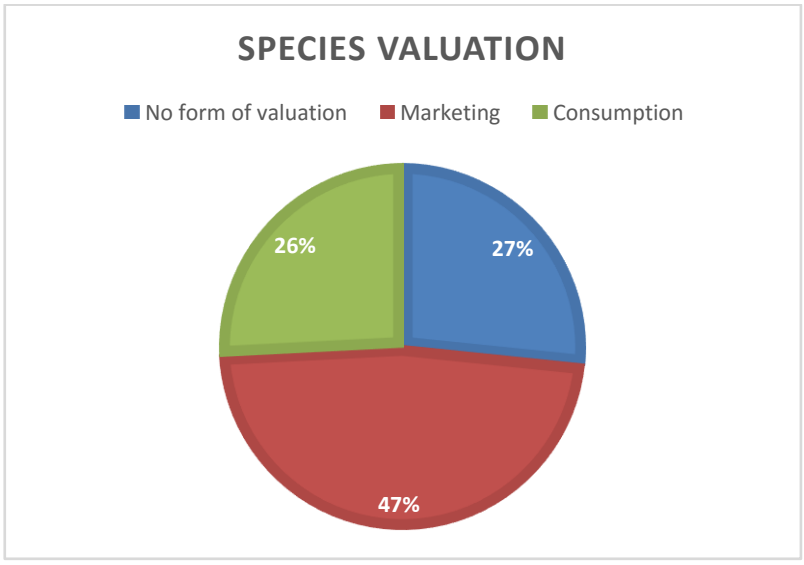
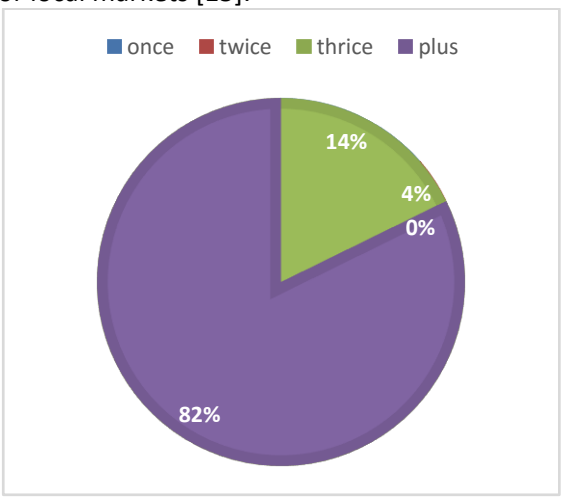


Figure 1 : Forms of the red swamp crayfish valorisation in Morocco, field survey 2016, 2017 et 2018, Morocco.

100% of the people surveyed are engaged in fishing and selling fish as well. A large part of them confirmed that they fish and sell crayfish several times a month (figure 2) with different quantities (figure 3) only at the local level. As in France and Italy, fishing activities exist on this species mainly for local markets [15].



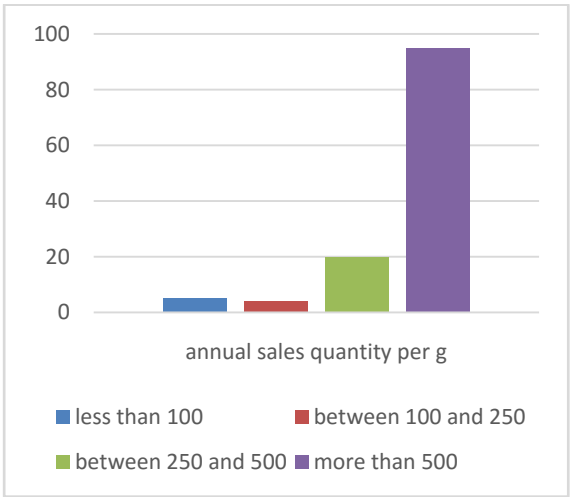
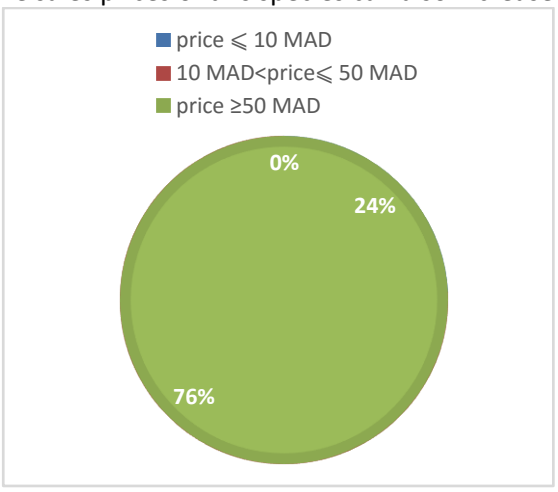


Figure 2. Number of sales per month, field survey 2016,2017 and 2018, Morocco

Figure 3. Annual sales quantity per g, field survey 2016,2017 and 2018, Morocco

Fishers report that the price of red swamp crayfish ranges from 10 MAD to 50 MAD or 0,093 euro to 4,66 euro (estimate at 29/12/2019), depending on the availability of the stock and the quantity fished, which also varies with the seasons of abundance of the species (figure 4) especially if demand increases and the quantity of crayfish caught is limited. Client status can also play a role in price variation; fish sellers buy it to sell small crayfish to fishermen who use it as fishing bait at a lower price, and sell large crayfish to tourists who know its value at a price not exceeding 50 MAD (4.66 euro) per kg (figure 5). The commercial value of crayfish depends on supply and demand, the sales prices of this species can also increase with individual size and quality [16, 17].



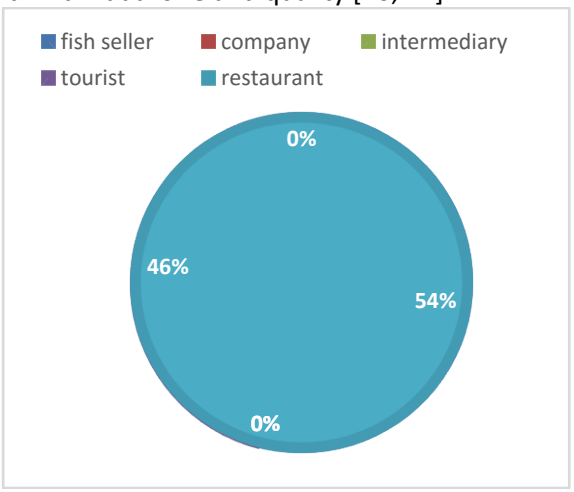


Figure 4. Sale's price per Kg, field survey 2016,2017 and 2018, Morocco

Figure 5. Customer status, field survey 2016,2017 and 2018, Morocco

In other countries such as Spain, crayfish prices close to 3 euros/kg were recorded in the 1980s, at the start of production, as in Morocco at present, and in 1990 the price stabilized at 1.4 euros/kg, but sometimes reaching close to 10 euros/kg [16], and in 2014 the price has been further reduced to 0.40 euro/kg [17, 18]. Demand outstripped supply in France and Italy, with prices reached 15 euro /kg [19, 15].

82% of fishermen sell crayfish several times a month. Assuming that the species is sold with 500g at least four times a month, i.e. 2 kg, which gives an estimate of 24 kg per year, so the income varies between MAD 240 (22,19 euro) and MAD 1200 (110,95 euro) for every fisherman. If we calculate the minimum quantity of crayfish sold per year we find 24 kg*124 fishermen= 2976 kg, this quantity sold in Morocco is still too low compared to Spain, which is the third-world producer with 4.1% of the total biomass, i.e. an average of 3,700 t/year [20].

The introduction of this crayfish in Morocco generated a fishing activity as everywhere else in the world [16]. However, this activity is still limited and weak and is not developed in comparison with other neighbouring countries such as Spain and Portugal [16, 17, 21] due to the absence of a real, well-structured crayfish market, the instability of the demand for this product, and the absence of industrial structures which are responsible for processing or exporting crayfish such as Spain, France, Sweden, Belgium and Denmark [16] and in recent years even to China and USA [19, 17].

The fishery sector in Morocco plays a major socio-economic role and is one of the pillars of the national economy, Crayfish fishing in Morocco provides a more or less interesting income to local fishermen from its commercialization. The red crayfish is known worldwide for its ability to provide a wide variety of services, including direct economic benefits, to mankind [22]. The

presence of red crayfish has contributed a dynamic in this strategic sector especially in terms of employment, food security and income, as well as creating a dynamic for other sectors of the national economy such as tourism , and it can generate a good profits if it's properly exploited.

3.2. Control methods

78% of farmers report that the presence of red crayfish in their cultivated fields is harmful (Figure 6). The red swamp crayfish causes various types of damage (Figure 7) that sometimes exceeds the harvest benefit [23].

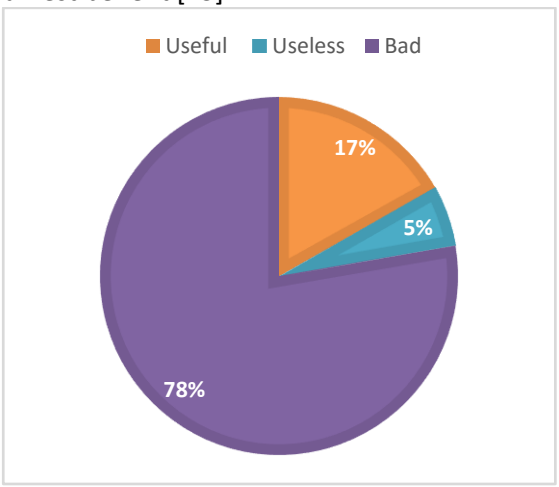


Figure 6. Farm impact in rice fields,farmers' responses, field survey 2016, 2017 and 2018, Morocco.

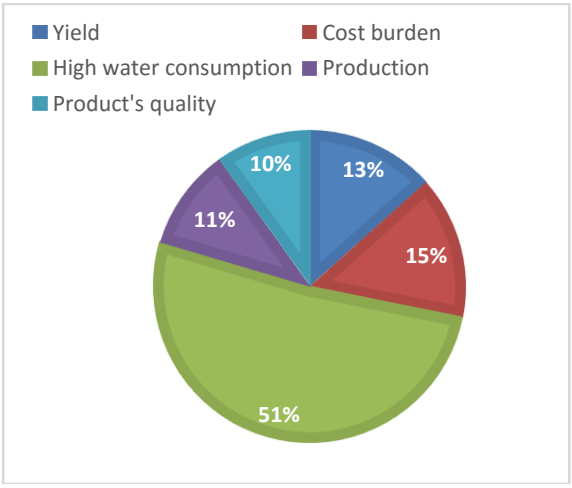


Figure 7. Species utility, farmers' responses, field survey 2016, 2017 and 2018, Morocco.

Several control methods are already known and applied to red swamp crayfish worldwide such as trapping, construction of physical barriers, biological control, chemical control, sterilization of males, and the use of pheromones as bait for traps [24].
In Morocco this species is an alien species and no control method is recommended by the relevant authority, so farmers have taken the initiative to control this species to save their crops (Figure 8).

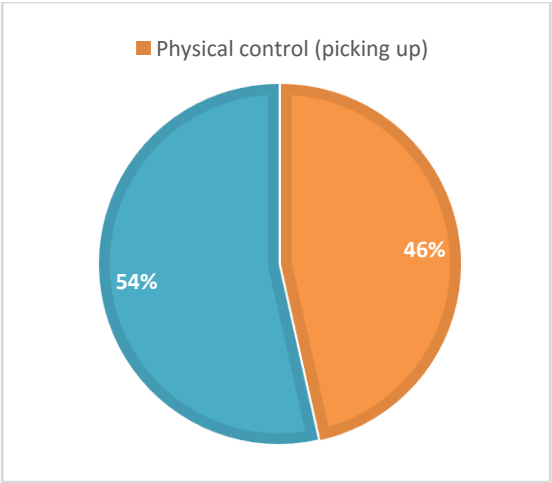


Figure 8. Nature of control in rice fields,farmers' responses, field survey 2016, 2017 and 2018, Morocco.

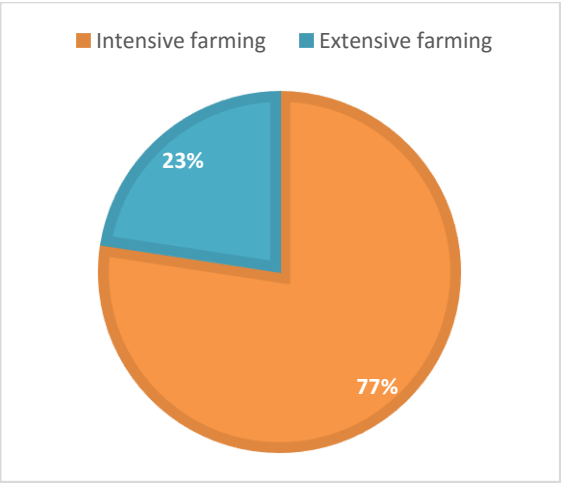


Figure 9. Proposal exploitation, farmers' responses, field survey 2016, 2017 and 2018, Morocco.

54% of farmers use non-authorized chemicals to control this species and that their prices according to them vary between 20 and 100 MAD per liter or 1,87 to 9,36 euro (estimate at 29/12/2019). The problem in this method that farmers clearly state that this method makes them spend an additional money and they do not know if these products are toxic or not.
The introduction of red crayfish has an impact on provisioning services, such as reducing the value of edible native species, regulatory and support services, inducing broad changes in ecological communities, and increasing costs to agriculture and water management (Figure 7) [25, 26].
46% of farmers physically collect crayfish using blocks, nets, and nares. This technique requires a lot of effort and its results are not efficient enough, for example the use of conditioned water by receptive females [27] or live crayfish [28] has been shown to be a very selective bait to attract sexually mature males in traps [29].
Other studies propose the integration of crayfish with rice cultivation as an alternative to mitigate the socio-economic impact of crayfish and to control crayfish populations in rice-field areas [30, 31].
77% of farmers suggest intensive animal husbandry as a means of controlling crayfish populations [32, 33, 25] and economic benefit (Figure 9).
A cost-benefit analysis [34] should be carried out to evaluate the control strategy put forward by farmers and find the most effective strategy in terms of crayfish control and the least expensive.
It is necessary to quantify the impacts caused by red swamp crayfish on ecosystem services in order to better inform management decisions and to have a reliable cost-benefit analysis [24, 25, 35].

3.3. The red swamp crayfish consumption

The average world production of red crayfish for consumption has increased by almost 200% per year and in 2008 reached 41,704 tonnes and USD 1,862,938 [8], which shows that food based on this species is increasing day after day worldwide [25].
In Morocco, as this species is recently introduced, is an unknown alien species for the local population, its consumption pattern and consumers remain modest. 38% of the people surveyed consume this species compared to 62% who do not consume it due to its unknown status in the region (Figure 10).

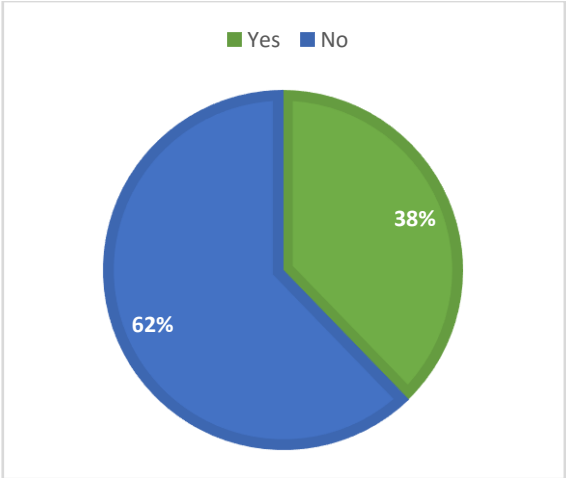


Figure 10. Consumption of Procambarusclarkii, local population response, field survey 2016, 2017 and 2018, Morocco

By surveying the consumer of this species how often this species is present in their diets per month (Figure 11) and how much is consumed (Figure 12). 32% crayfish is present in their meals only twice a month, 26% more than four times which shows that they take crayfish as an essential food in their diet, and 21% eat crayfish only once a month in amounts ranging from 50g to more than 250g.

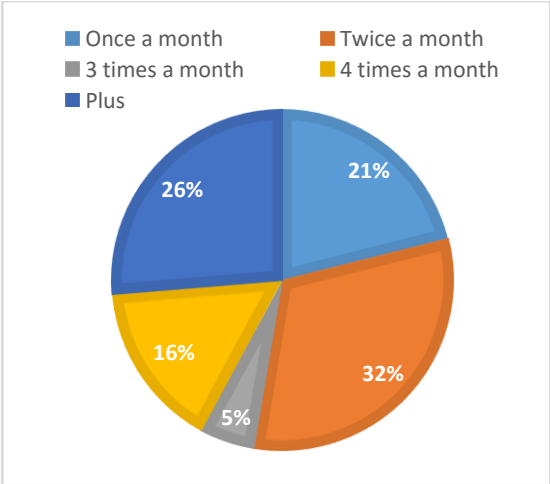


Figure 11. Species consumption frequency, local population response, field survey 2016, 2017 and 2018, Morocco

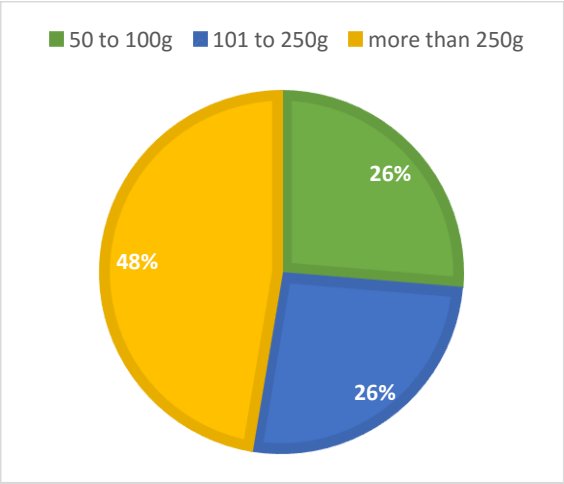


Figure 12. Quantity consumed per time, local population response, field survey 2016, 2017 and 2018, Morocco

Despite this, consumption and the amount consumed per month remains very modest compared to other countries such as Spain, which has several plants producing different crayfish feeds to meet the demand [36].

84% of people who consume red crayfish confirm that this species has no effect on their health, while a small proportion report that after consuming this species they had symptoms of allergy, vomiting and diarrhoea (Figure 13). On the other side, in the living state this species stung 26% of the people surveyed, 23% did nothing, and 8% created a harmless state for them (Figure 14).

Such consumption and contact with red crayfish should be controlled by the authorities concerned as this species is known to be a possible agent of transmission of the bacterium *Francisellatularensis* [37] and other parasites [38, 39] in humans.

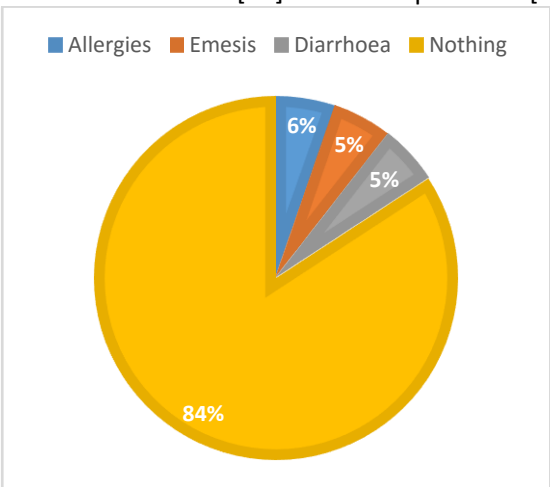


Figure 13. Adverse health effects, local population response, field survey 2016, 2017 and 2018, Morocco

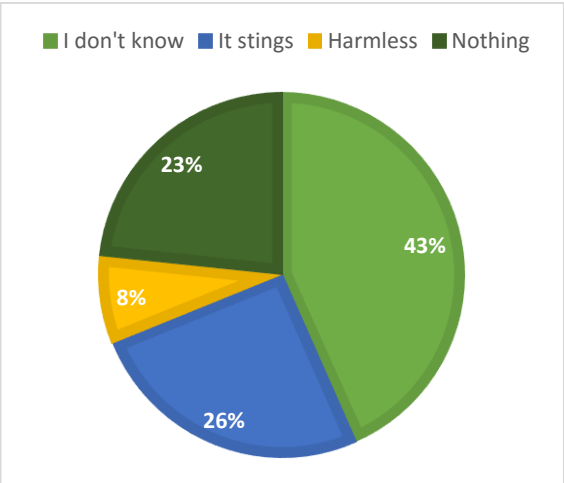


Figure 14. Species attack, local population response, field survey 2016, 2017 and 2018, Morocco

Several studies have shown the importance of controlling the use of red crayfish in consumption, especially crayfish carrying crayfish plague [40, 41, 42].

The increase in fishing for this species and its sale mainly for human consumption carries the risk of a wide spread of this species in uninvaded areas as an economic resource [40, 43].

4. CONCLUSION

Morocco is one of the top African countries in the production and export of fishery and crustaceans products. The red swamp crayfish fishery provides increased revenues to the domestic fishing sector.
Data on catches and sales of *Procambarusclarkii* in Morocco, their value and economic impacts are scarce and difficult to determine. Thus, the socioeconomic relevance of the presence of this species in Morocco is underestimated, as production and revenues are probably much higher than reported.

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AUTHORS CONTRIBUTION

SS: Data collection and manuscript writing
MA: Statistical analysis
SA and SS: Data interpretation
JEH: Designed research methodology and Manuscript final reading
EAEMM: Conceived idea and manuscript finalApproval

REFERENCE

[1]. Hulme P.E. (2007). Biological Invasions in Europe : Drivers, Pressures, States, Impacts and Responses. In: Hester R and Harrison RM (eds) Biodiversity Under Threat Issues in Environmental Science and Technology, 25, pp.56-80.
[2]. Millenium Ecosystem Assessment, 2005. Ecosystems and human well-being: Biodiversity synthesis, World Resources Institute, Washington, D.C.
[3]. Huner J.V, 2002. Procambarus. In: Holdich D. (ed.), Biology of Freshwater Crayfish. Blackwell Sciene Ltd., Oxford, 541–584.
[4]. Basilico L., Damien J.-P., Roussel J.-M., Poulet N. et Paillison J. –M., 2013. Les invasions d'écrevisseexotiques, impacts écologiquesetpistes pour la gestion. Synthèse des premières « Rencontres nationales sur les écrevissesexotiquesinvasives », 19 et 20 juin 2013. 41 pp.
[5]. Reynolds, J.D., Souty-Grosset, C., 2012. Management of freshwater biodiversity:crayfish as bioindicators. Cambridge University Press, Cambridge, UK.
[6]. Capinha C., Leung B. and Anastacio P., 2011. Predicting worldwide invasiveness for four major problematic decapods: an evaluation of using different calibration sets. Ecography 34, 448−459.
[7]. Laurent P. J., 1997. Introduction d'écrevissesen France etdans le monde, historique et conséquences. Bull. Fr. PêchePiscic., 344-354.
[8. F.A.O :Organisation des Nations Unis pour l'Alimentation et l'Agriculture, Département des pêches et de l'aquaculture. *Procambarusclarkii* (Girard, 1852). URL http://www.fao.org/fishery/culturedspecies/Procambarus_clarkii/fr.
[9]. Roqueplo C., Laurent P.J., Neveu A. 1995. *Procambarusclarkii* Girard (Ecrevisse rouge des marais de Louisiane), synthèse sur les problèmesposés par cetteespèceet sur les essais pour contrôlercette population. Première partie. L'Astaciculteur de France. 44. p 2-14.

[10].Magin C (2001) Morocco. In Fishpool LDC and Evans MI (Eds.) Important Bird Areas in Africa and Associated Islands: Priority sites for conservation. Newbury and Cambridge UK: Pisces Publications and Birdlife International (BirdLife Conservation Series n° 11).
[11]. Ramdani M (1988). Les eauxstagnantes du Maroc: étudesbiotypologiqueetbiogéographique du zooplancton. Travaux de l'InstitutScientifiqueSérieZoologie Rabat, 43: 40 pp.
[12]. Snoussi M, Ouknine L (2006). Water, salt and nutrient budgets for MoulayBousselham lagoon, morocco LOICZ- Biogeochemical Modelling Node, University Mohamed V, Faculty of Sciences, Department of Earth Sciences, B.P. 1014 Rabat, Morocco.
[13]. Mofi. 2003. Progress report 2002 and workplan 2003. Ministries of Fisheries.
[14]. Saguem, S, El Alami El Moutaouakil, M, Study on the Spread of *Procambarusclarkii* at Gharb (Morocco) and Its Impact on Rice Growing, Journal of Agricultural Science and Technology A 9,2019, 86-88.
[15]. Simoni, F., di Paolo, C., Mancino, A., Simoni, F., Falaschi, A., 2004. Microcyst in concentrations in water and ichthyo fauna of MassaciuccoliWetlands(Tuscany). Harmful Alga News 25, 4–6.
[16]. Gutiérrez-Yurrita, P.J., Martínez, J.M., Ilhéu, M., Bravo-Utrera, M.A., Bernard, J.M.,Montes, C., 1999. The status of crayfish populations in Spain and Portugal. In:Gherardi, F., Holdich, D. (Eds.), Crayfish in Europe as Alien Species: How toMake the Best of a Bad Situation? Crustacean Issues, vol. 11. A.A. BalkemaRotterdam, pp. 161–192.
[17]. MBC, (Mediterranean Business Consulting, S.L.), 2001. Estudiosobre el impactoeconómicodel sector de cangrejo de ríoen Andalucía. Consejería de Agricultura y Pesca. Junta de Andalucía, Viceconjeria, Sevilla.
[18]. El Mundo, 2014. El cangrejorojosobrevive al ladrillo. ECONOMÍA: El crustáceodelasmarismas de Sevilla, Unidad Editorial Información General S.L.U., 17Noviembre 2014 edición.
[19]. Rodrigo I., Bandeiras, C., Ferreira, A.P., 2006. Estudoestratégico para a gestãodaspescascontinentais. PAMAF Medida 4-IED, Acc¸ ão 4.4: Estudosestratégicos.Instituto da Conservac¸ão da Natureza e das Florestas.
[20]. Seaweb, Guide des espèces à l'usage des professionnels Pour unmarchédesproduits de la mer durables—Édition 2014. EUROPE. 2014.
[21]. Agence de L'Eau, 2002. Les espècesanimalesetvégétalessusceptibles de prolifériérdans les milieuxaquatiques et subaquatiques. Diplômed'EtudesSupérieuresSpécialisées, Gestion des RessourcesNaturellesRenouvelables Cécile Nepveu2001–2002.
[22]. Souty-Grosseta C., Anastáciob P.M., Aquilonic L., Banhab F.,Choquera J., Chucholld C.,Tricarico E., 2016, The red swamp crayfish *Procambarusclarkii* in Europe: Impacts on aquatic ecosystems and human well-being, Limnologica 58 (2016) 78–93.
[23]. Anastácio, P.M., Parente, V., Correia, A.M., 2005. Crayfish effects on seeds andseedlings: identification and quantification of damage. Freshw. Biol. 50,697–704, http://dx.doi.org/10.1111/j.1365-2427.2005.01343.x.
[24]. Gherardi, F., Aquiloni, L., Diéguez-Uribeondo, J., Tricarico, E., 2011. Managing invasive crayfish: is there any hope? Aquat. Sci. 73, 185–200.
[25]. Lodge, D.M., Deines, A., Gherardi, F., Yeo, D.C.J., Arcella, T., Baldridge, A.K., Barnes,M.A., Chadderton, W.L., Feder, J.L., Gantz, C.A., Howard, G.W., Jerde, C.L., Peters,B.W., Peters, J.A., Sargent, L.W., Turner, C.R., Wittmann, M.E., Zeng, Y., 2012.Global introductions of crayfishes: evaluating the impact of species invasionson ecosystem services. Annu. Rev. Ecol. Syst. 43, 449–472, http://dx.doi.org/10.1146/annurev-ecolsys-111511-103919.
[26]. Reynolds, J.D., Souty-Grosset, C., 2012. Management of freshwater biodiversity:crayfish as bioindicators. Cambridge University Press, Cambridge, UK.
[27]. Stebbing, P.D., Watson, G.J., Bentley, M.G., Fraser, D., Jennings, R., Rushton, S.P.,Sibley, P.J., 2004. Evaluation of the capacity of pheromones for control ofinvasive non-native crayfish: part 1. English Nature Research Reports No. 578,English Nature, Peterborough, UK.
[28]. Aquiloni, L., Gherardi, F., 2010. The use of sex pheromones for the control ofinvasive populations of the crayfish Procambarusclarkii: a field study.Hydrobiologia 649, 249–254.
[29]. Piazza, F., Aquiloni, L., Manfrin, C., Simi, S., Duse Masin, M., Florian, F., Marson, L.,Peruzza, L., Borgogna, M., Paoletti, S., Bonzi, L., Scapini, F., Faraoni, P., Balzi, M.,Edomi, P., Giulianini, P.G., Development of methods for the containment andthe capture of P. clarkii, in: rARITY. Eradicate invasive Louisiana red swamp andpreserve native white clawed crayfish in Friuli Venezia Giulia. Published by thefinancial contribution of the EC within the RARITY project LIF NAT/IT/000239,pp., 144 2014, E10.
[30]. Anastácio, P.M., Nielsen, S.N., Marques, J.C., Jørgensen, S.E., 1995. Integrated production of crayfish and rice: a management model. Ecol. Eng. 4, 199–210.

[31]. Anastácio, P.M., Frias, A.F., Marques, J.C., 1999a. CRISP—crayfish rice integrated system of production : 1 Modelling rice (Oryza sativa) growth and production.Ecol. Model 123, 17–28.
[32]. Hein, C., Vander Zanden, M.J. & Magnuson J.J. (2007). Intensive trapping and increased fish predation cause massive population decline of an invasive crayfish. Freshwater Biol., 52, 1134-1146.
[33]. Jones, J., Rasamy, J., Harvey, A., Toon, A., Oidtmann, B., Randrianarison, M.H., Raminosoa, N. &Ravoahangimalala, O.R. (2009). The perfect invader: a parthenogenic crayfish poses a new threat to Madagascar's freshwater biodiversity. Biol. Invas., 11, 1475-1482.
[34]. Keller, R.P., Frang, K., Lodge, D.M., 2008. Preventing the spread of invasive species:economic benefits of intervention guided by ecological predictions. Conserv.Biol. 22, 80–88.
[35]. Geiger, W., Alcorlo, P., Baltanás, A., Montes, C., 2005. Impact of an introduced Crustacean on the trophic webs of Mediterranean wetlands. Biol. Inv. 7, 49–73.
[36]. Junta de Andalucía, 2007. El cultivodelarrozen Andalucía. Versión 1. SecretaríaGeneral E Agricultura, Ganadería Y Desarrollo Rural. Consejería de AgriculturayPesca.
[37]. Anda, P., Segura, J., D´ıaz, J.M. et al. (2001). Waterborne outbreak of tularemia associated with crayfish fishing. Emerg. Infect. Dis., 7, 575-582.
[38]. Longshaw, M., 2011. Diseases of crayfish: a review. J. Invertebr. Pathol. 106, 54–70.
[39]. Souty-Grosset, C., Holdich, D.M., Noël, P.Y., Reynolds, J.D., Haffner, P., 2006. Atlas of Crayfish in Europe. Muséum National d'HistoireNaturelle, Paris,PatrimoinesNaturels, 64, p. 187. ISBN: 8562535798.
[40]. Chucholl, C., 2013. Invaders for sale: trade and determinants of introduction ofornamental freshwater crayfish. Biol. Inv. 15, 125–141.
[41]. Mrugała, A., Kozubíková-Balcarová, E., Chucholl, C., CabanillasResino, S.,Viljamaa-Dirks, S., Vuki´c, J., Petrusek, A., 2014. Trade of ornamental crayfish inEurope as a possible introduction pathway for important crustacean diseases: crayfish plague and white spot syndrome. Biol. Inv. 17, 1313–1326, http://dx.doi.org/10.1007/s10530-014-0795-x.
[42]. Patoka, J., Kalous, L., Kopeck´y, O., 2014. Risk assessment of the crayfish pet tradebased on data from the Czech Republic. Biol. Inv. 16, 2489–2494, http://dx.doi.org/10.1007/s10530-014-0682-5.
[43]. Nun˜ ez, M.A., Kuebbing, S., Dimarco, R.D. &Simberloff, D. (2012). Invasive species: to eat or not to eat, that is the question. Conserv. Lett., 5, 334-