

Eating Lionfish: An Effective Solution to Control its Invasion?

Consumo de Pez León: ¿Solución efectiva para Controlar su Invasión?

Manger Lionfish: Une Solution Efficace pour Controler son Invasion?

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ABSTRACT

Biological invasions represent a serious threat to biodiversity because they cause extinctions to native species through predation, competition, and diseases, which in turns may cause economic losses. The Indo-Pacific red lionfish, *Pterois volitans*, was introduced, intentionally or accidentally, into the waters off Florida, USA, back in the 1980s, and now the population growth of this fish turned out to be a biological invasion that threatens the coral reef biodiversity in the Western Atlantic. As an alternative for management and control of its invasion, government and conservation groups from the region are now recommending physical removal methods as a measure of eradication, including derbies, safaris and fishing tournaments. At the same time, those groups suggest the lionfish as candidate for human consumption through gastronomic delicacy. In fact, since 2010 various fisher groups in the Bahamas, Belize and Mexico have organized lionfish degustation events where local people liked eating the fish as ceviches and fish fingers. In this work, I discuss the viability of promoting such gastronomic use which it may foster the creation of an international market that, if economically attractive to people, it may generate the opposite results to those proposed for eradicating this invasive fish.

KEY WORDS: lionfish, gastronomic use, fishing derbies, eradication method, invasive species

INTRODUCTION

Biological invasions threaten the biological diversity integrity and function causing extinctions to native species through predation, competition, and diseases (Mack et al. 2000), and at the same time they also cause economic losses (Pimentel et al. 2000). How introduced species become invasive depends on their biological attributes and the environmental conditions of the habitat (Pyzek and Richardson 2010). Drivers promoting new introductions relate to human activities: agriculture, hunting, fishing, and ornamental trade (Pimentel et al. 2000, Simberloff et al. 2005). By contrast, some introduced species - food crops (e.g. corn, wheat) and livestock (e.g. cattle and poultry) - benefit humans economically.

Proposed solutions to eradicate invasive species include: mechanical removal, biological control, or even chemical application (Simberloff et al. 2005). The idea of using invasive species for human consumption dates back to the 1990s, mainly for introduced plants (Rapoport et al. 1995, Díaz-Betancourt et al. 1999). Now, many government agencies and conservation groups consider this “gastronomic use” for the invasive species as a measure of population control. However, many non-native plants and animals – introduced either intentionally or unintentionally – rather than being extirpated from invaded habitats now represent staple items on the menu (Nuñez et al. 2012, Barclay 2011, Minsky 2011).

The red lionfish (*Pterois volitans*) and the devil firefish (*P. miles*), venomous fish natives to the Indo-Pacific Ocean, were introduced by aquarium hobbyists in the Florida waters back in 1980s (Morris and Whitfield 2009). In particular, *P. volitans* experienced a population explosion and invaded areas from the Bahamas to Venezuela, including the Gulf of Mexico and Caribbean Sea (Schofield 2010). While the impact of this predator fish on the native organisms is unknown, it reduced 65%, on average, the biomass of native fish (small-sized fish) in coral reefs of The Bahamas in two years (Green et al. 2012). Current strategies for lionfish population growth control – proposed by conservation non-governmental organizations and managers – work on physical removals through derbies and fishing tournaments (REEF 2012).

The strategy gaining more popularity promotes a gastronomic use of the lionfish (Morris and Whitfield 2009, Rosenthal 2011) because its venom resides in the fin spines, so its flesh is toxin-free and edible (Morris et al. 2011). While the lionfish fillet market could be an attractive mechanism for local fishers’ investment and an alternative to fight population growth at the same time, marketing an invasive species whose population is expected to be extirpated from the coral reefs may render the opposite results. The objective of this work is to discuss how viable could the gastronomic use be as measure of eradication of the lionfish population in the region, with particular emphasis on Mexico.

INVASIVE SPECIES: ARE THEY PROBLEMATIC OR BENEFICIAL?

Introduced organisms receive various names, such as non-indigenous, alien, exotic, and invasive (Colautti and MacIsaac 2004). The term invasive, used in much scientific literature, implies damaging species that affect the natives. However, Richardi and Cohen (2007) suggested the term invasive should not be used to connote negative environmental impact; since some invasive species that spread and establish rapidly are not, on average, also those with significant impacts on native species populations. Valéry et al. (2008) established a viable definition of a biological invasion as that occurring when “a species acquire a competitive advantage when natural obstacles disappear to its proliferation, which allows it to spread

rapidly and to conquer novel areas within recipient ecosystems in which it becomes a dominant population". Besides the ecological meaning of invasive species, the introduced species become invasive when they produce significant economic and ecological losses (Parker et al. 1999).

Many terrestrial animals, introduced for multiple purposes, have become invasive affecting native organisms. However, many of those introduced species have become economically important. For many years, non-native species, such as the wild boar or "jabalí (*Sus scrofa*), the hare (*Lepus europaeus*), and the red deer (*Cervus elaphus*), represent millions of dollars for hunting business and the expensive gastronomy (Lambertucchi and Speziale 2011, Nuñez et al. 2012). These animals come either from the US to South America, from the US to Europe or from Asia to the US; and instead of devoting efforts for their eradication, people want to keep them because those animals represent an investment. People are protecting the invaders for profit (Lambertucchi and Speziale 2011). Introduced animals in aquatic environments are not the exception; such is the case of salmonids (*Salvelinus* sp., *Salmo* sp., *Oncorhynchus mykiss*) (Nuñez et al. 2012), carps (*Cyprinus* spp.) (Vilizzi 2012), and the tilapia (*Oreochromis*, *Tilapia*, and *Sarotherodon* spp.) (Canónico et al. 2005). These fishes are highly valued by people who invest money for the aquaculture and fishing industries. Tilapias, for example, are freshwater fishes native to Africa and introduced to America (Canónico et al. 2005) that became the "aquatic chickens", since they are a high-yield source of protein raised easily in environments from subsistence or 'backyard' units to intensive fish hatcheries (Coward and Little 2001). However, tilapias are responsible for population declines of native tilapias threatening the local biodiversity. Thus, despite of their documented environmental impacts, introduced tilapias are an economic food resource for local communities (Canónico et al. 2005).

Then, some introduced non-native species are beneficial to the economy despite being deleterious to the ecology (Lambertucchi and Speziale 2011). It is the people in the business who often dictate the route introduced species may have in the new habitat. Governments also promote new markets often without knowing the ecological consequences those markets will have. So, the answer to the question of whether introduced species are problematic or beneficial depends on the viewpoint. For entrepreneurs, it is economics for the short term, but if the market finds its way to be permanent so the market is profitable. For the ecology, it is obvious that invaders are problematic. The issue of dealing with non-indigenous, introduced species is exacerbated in developing countries by the lack of funding to better monitor them, recruit volunteers, and find well planned initiatives (Nuñez and Pauchard 2010). It is the developing countries that threaten biodiversity through international trade, a potential introduction of non-indigenous species (Lenzen 2012).

IS A VIABLE SOLUTION MARKETING LIONFISH "FILLETS" TO REGULATE ITS POPULATION?

Lionfish (*P. volitans*) was introduced to the Americas, specifically the United States, through the international aquarium trade. How and when this fish ended up on coral reefs is unknown (Morris and Whitfield 2009); however, what scientists know is that the lionfish became an invasive species in the Western Atlantic (Schofield 2010). As best option for controlling or eradicating the lionfish population from the coral reefs, scientists and managers recommend mechanical removal (Barbour et al. 2011), but some propose natural biocontrol (Mumby et al. 2011); this latter could be viable only if the natural predators (potentially groupers) are abundant. For mechanical removal, managers and scientists encourage volunteers to participate in derbies, rallies, or fishing tournaments (Morris and Whitfield 2009, Morris 2012). From 2009 to 2012, the non-governmental Reef Environmental Education Foundation (REEF) has organized derbies in the Florida Keys (US) and The Bahamas from which participants have captured about 10,200 lionfish (REEF 2012).

Popular media endorses the possibility that eating lionfish is the solution to its invasion (Reynolds 2011, Rosenthal 2011), and many people have even suggested recipes for cooking it (Walton 2011, Quist 2011, Grandison 2012). The National Oceanic and Atmospheric Administration (NOAA) promoted the "Eat Lionfish" campaign (NOAA 2011), and REEF introduced the first cook book for lionfish (REEF 2011). Many restaurants in USA, the Bahamas and many countries in the Caribbean are now including it in their menus. Some restaurants offer it as an exotic delicacy while others as a "common fish" (Rosenthal 2011). People consider that by eating lionfish the coral reefs are safer because an invader is being removed. Many well-known scientists (Safina 2012, Roman 2012) are also endorsing the "Eat Lionfish" campaign.

While "consuming the invader" campaign is not exclusive of the lionfish, since many other aquatic and terrestrial species are also recommended for consumption (Roman 2012), the problematic situation of marketing an invader resides on the possibility that the expected results – eradication – could go in the opposite direction (profit) (Nuñez et al. 2012). If the new market is profitable, people investing in the market may want the "product" to remain. This could be fostered by consumers who, once they try the "new product", they will want more of it and even will pay more for it. Many terrestrial plants and animals are now valuable species after they reached the cultural key point in people it would be practically impossible to deal with the species for eradication; an example of this are the horses, crops, cats, dogs, and of course the wild boar, hare, red deer, nutria, without mentioning the many wild plants (Nuñez et al. 2012).

Consequently, what is the point when promoting the consumption of lionfish? Do we, as scientists, really want to create a beneficial local market for fishers and at the same time fight the invasion to save the reefs? By promoting the establishment of a new market; then, do we really want to eradicate a “valuable new resource” or “keep that resource for perpetuity”? How should we proceed when promoting the gastronomic control for lionfish for avoiding unexpected results in the market arena? We, as scientists, understand what is behind lionfish consumption. What we really want is to have more volunteers removing the fish but at the same time we want to scientifically record those removals and understand the lionfish invasion better. By contrast, from the entrepreneur point of view, they will want to earn what they invested for and if this is not the case they may have two options:

- i) To recreate the invasion conditions on common grounds of their own control, which would be like maintaining the lionfish until it reaches a marketable size, such as ranching chickens, or
- ii) To drop the market because it is not profitable.

More questions arise on this, such as do we need to label the “lionfish fillet”, arguing that by consuming lionfish are we helping the coral reefs? What could happen if people very much enjoy the new seafood and want to pay for it? What will the restaurant owner do if people want to eat more lionfish? What would happen if there is not enough volume of lionfish to satisfy “exclusive appetites” and restaurant owners need a reliable, consistent supply? How can we persuade fishers to invest their low income on a new “temporary fishery” if the fishery is expected to disappear in the long run? The fishery could be considered temporary because it is assumed that the population has to be kept on low levels. If the market is viable and there are entrepreneurs interested in trading “lionfish fillets”, how will newcomers to the market react if they are far from areas where lionfish are abundant? Will they want to recreate their own “fishing sites” by dumping some “lionfish seeds” to have their own fishing sites? It is highly possible that those people investing in the lionfish trade will never want to have their market disappear.

Legal requirements for the establishment of a lionfish fishery must consider: special fishery permit to control the amount of people, participants have to attend a special course about the implications of the lionfish invasion, special labeling for the lionfish fillet coming from a certified fishery. In other words, it would be necessary to involve responsible people deeply compromised with keeping lionfish out from the reefs but obtaining a living from their harvest. However, if the lionfish market is lucrative and there is higher demand for fillets, it would be easier for those irresponsible to turn the removals be more beneficial for their pockets than for the environment. Some of these concerns are addressed by Buddo (2012).

Two components must be considered when promoting the gastronomic use of lionfish:

- i) How to make people like it, and
- ii) How to keep the market going if people like it and want more.

For i) you can propose the most palatable recipes for making this fish culinary attractive. Once you achieve such a difficult endeavor, and people request to eat lionfish, it could be a staple item on the menu. Thus, it could become economically attractive so entrepreneurs would like to sell more lionfish fillets, and these entrepreneurs would not want this fish to be eradicated because it is now valuable. What began as an useful eradication method now has become a demonstration of a new marketable product.

LIONFISH COMMERCE IN MEXICO

Since 2009, the federal government, through the Comisión Nacional de Áreas Marinas Protegidas (CONANP), addressed the lionfish invasion in the Mexican Caribbean, particularly in the Parque Nacional Arrecifes de Cozumel. CONANP has organized from 2009 to 2012 at least four lionfish fishing tournaments in Cozumel, Quintana Roo, in which local participants (mostly fishers) captured about 8,000 lionfish (Do Castella 2012). Recently, CONANP promoted the consumption of lionfish (CONANP 2012), supported by NOAA, and elaborated a local cookbook in which restaurant owners participated (CONANP 2011). Quintana Roo is the only state in Mexico where a “lionfish fishery” has been established with support of CONANP. Fishers from Cozumel, specifically the Fishers Group (Cooperativa) “Sociedad Cooperativa de Producción Pesquera Cozumel S.C de R.L.” pioneered finding ways to sell lionfish fillet locally and even internationally. Eduardo Pérez Catzín – president of the cooperative – argues that *everything began as an experiment or adventure with a friend who exports seafood to US*. Catzín and his 48 members attempted to find a market in other regions of México (Pérez 2012). This cooperative sells the lionfish fillet in US \$11 per kg and the whole fish in US\$ 5 and has participated in local events for promoting their sales and teach people how to cook the lionfish.

Despite beneficial attempts to fight the lionfish invasion through mechanical removal and consumption, the environmental authorities, such as the Secretaria de Medio Ambiente y Recursos Naturales (SEMARNAT) remain apparently without direct interest since no legal documents exist to recognize the lionfish as an invasive species. While the lionfish fishery is *irregularly* under development, the Comisión Nacional de Pesca (CONAPESCA) does not have any initiative to analyze the situation (Aguilar-Perera and Carrillo-Flota, In press). Consequently, no permits or authorizations are required for any person to remove or initiate commerce of lionfish fillets or whole. The only difference is for those who have

enough funds to pay for fishers for removals and processing and to find international markets. From this disorganized market may originate malicious incentives to either monopolize markets or even prevent benevolent people to make a living of the new market. Things could get even worse if the lionfish becomes a staple in the menu.

The personnel of the Parque Nacional Arrecifes de Cozumel covered very important stages to link local fishers, managers and scientists to address the invasion. However, it is imperative that SEMARNAT and CONAPESCA recognize the lionfish as either an ecological threat or a viable fishery resource. Organization and proper funding, either national or international, are urgently needed for a permanent monitoring of lionfish population in Mexico. Fishing tournaments and bounty programs are useless if no permanent monitoring is established where a national database is implemented. For instance, few people know how many derbies or fishing tournaments have been organized in Quintana Roo. Apparently, CONANP has organized only four fishing tournaments from 2009 to 2012 (Do Castella 2012), but no information is available on how many others have been organized in any other natural protected area or outside protected areas. Besides, relatively nothing is known on how many lionfish from Cozumel or any other place have been removed by fishers.

HOW EFFECTIVE COULD “EATING AN INVADERS” CAMPAIGNS BE?

Based on experiences in the terrestrial ecosystem dealing with the “eating the invasives” campaign as a measure of population control and recommendations by Nuñez et al. (2012), some caveats must be taken into account derived from promoting the lionfish market:

Environmental Benefits Derived from Consuming Invasive Species

Promoting consumption of invasive species may help on the following temporal advantages:

- i) Increases the awareness to the public about the presence of given invasive species in the environment,
- ii) Increases actions of people (volunteers) for early detection and fast response to address the invasion, and
- iii) Improves the local economy (temporarily) derived from the commerce (as an edible item) of the invasive species.

Problems Associated with Consumption of Invasive Species for Control of Population Growth

If the goals to address the invasion are not clear to the persons involved, some problems may appear which could affect negatively the efforts derived from initiatives to control the invasion. These problems could be:

- i) Failing to decrease the invasive population growth due to ecological attributes of the species (highly distributed, endurance to extreme conditions, deep habitats, low temperature, low salinity),
- ii) Failing to supply demands to the new market (for consumption) if the species is in low densities in some areas or it is located in remote areas.
- iii) If the removal campaign is successful, in terms of maintaining a lucrative market, entrepreneurs will only want to have more of the product no matter how or where this product is coming from. What began as a removal campaign may become a lucrative market that nobody would want to disappear.
- iv) Commercial activity could increase the value of invasive species much more than native species.

How to Avoid Unwanted Consequences from an “Eating the Invaders” Campaign?

- i) From the beginning of the removal campaign, it is crucial to establish clearly how the species has to be marketed:
 - a) Scientists must provide environmental education to managers, and then from managers to the public about the real purpose of the removal campaign.
 - b) Scientists must provide environmental education to entrepreneurs (who either buy or sell the invasive species) and remind them that the goal of the new market is to decrease population size and eradicate the species as much as possible.

“Eating the Invaders” Campaign may be Successful only if:

- i) Population size of invasive species is low,
- ii) The species is rare,
- iii) The species is in the early stages of its invasion,
- iv) Managers offer a coordinated process of education, removal, marketing, and consumption,
- v) Scientists provide timely studies on demographics of the invasive species,
- vi) Managers provide constant reminders that the campaign wants to decrease the population size of the species and to avoid creating a lucrative market,
- vii) Promising “eradication success” may avoid local participants getting frustrated. If eradication success is promised and the campaign fails, then the participants will leave and the invasive population will be out of control further, and
- viii) Government must prevent the social and commercial overvaluation of the invasive species.

HOW SAFE EATING THE LIONFISH COULD BE?

Effective removal campaigns for lionfish may be ineffective if the efforts to remove the fish are not constant. In fact, attempts to reduce its populations in large areas are not accomplished because this fish is able to recover fast after severe overfishing (Barbour et al. 2011). Thus, complete eradication of lionfish through fishing is unlikely. Efforts to remove lionfish may fluctuate highly due to the availability of *removers* (divers, fishers, etc) and their willingness to participate. Incentives for *removers* to participate include awards given through derbies, rallies, and fishing tournaments (REEF 2012). The human health risks associated to promoting lionfish removals, without the appropriate orientation to participants, relies on accidental venomous spine puncture when handling lionfish. Few documented cases of these accidents are available (Badillo et al. 2012); however, no campaigns are available on how to treat lionfish venomous punctures. In fact, emergency medicine to treat cases is needed because more accidents of this type are expected to increase.

“Eating the Lionfish” campaign is urged by government and conservations groups inviting people to remove as much lionfish as possible. However, what is the human health cost derived from this initiative? How is it possible to know how many fishers have been punctured by lionfish? Which health treatment did they follow? These assertions do not convey that doing nothing to fight the lionfish invasion is an option, but government and conservation groups must clarify which is the objective and where to go to. Even worse could be inviting local fishers to create a new market to lionfish fillet. In the case of Mexico, and Latin American, fishery options are needed for fishers to survive in the middle of depleted and overfished resources. A new fishery could be viable for fishers if they get revenues, and if there is constant demand and timely payments. If local fishers stick to the lionfish fillet and develop either national or international markets, and if they do not endorse the “lionfish eradication campaign”, it would be a useless effort of population control. Once a lucrative market is foreseen, fishers will never quit fishing, and they will even want to keep their market safe. This situation is occurring in Mexico, in the case of Cozumel and Puerto Morelos, Quintana Roo, where fishers are including lionfish as a new “fishery resource”.

In Mexico, a potential lionfish *fishery* could be viable if the following aspects are considered:

- i) Government fishery authorities include it in the National Fishery Chart,
- ii) Government certifies that participants (either fishers or recreational divers) on lionfish removals have taken a mandatory course on *human health risks when handling lionfish and responsibility to control lionfish populations*
- iii) Owners of fishery companies have taken similar courses to certify their lionfish sales,
- iv) Government implements licenses or permits to commercial companies able to trade in lionfish fillets, and
- v) Restaurants inform commensals about their participation on the lionfish control strategies by consuming lionfish.

Other recommendations could be taken into account, but the general idea is that all of the participants in the new market have to be responsible for accomplishing the goals of removing and consuming lionfish.

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