Islander perceptions of invasive alien species: the role of socio-economy and culture in small isolated islands of French Polynesia (South Pacific)

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Abstract Islands, often celebrated as natural laboratories for evolution and ecology, also provide unique experimental grounds for societal studies. Although biological invasions are widely recognised as one of the main causes of biodiversity erosion and a driver of global change, the human perception of invasive species may vary at regional and local levels, especially in societies with different levels of socio-economic development and cultures. This study was conducted in French Polynesia (South Pacific), a territory formed by 120 tropical and subtropical oceanic islands (76 being inhabited) divided into five archipelagos (Austral, Marquesas, Society, Tuamotu, and Gambier Is), comprising both highly populated and urbanised islands (such as Tahiti in the Society Is) and less populated and very small islands, sometimes very isolated (without airstrips) and where traditional life style and strong dependence on natural resources still persist. During an eight-month education and prevention campaign targeting alien plant and animal species legally declared invasive in French Polynesia, public meetings were organised on 19 small islands for a total of 2,045 consulted people in 41 different villages. Negative, positive and neutral comments made by participants on some invasive species present in their islands were recorded. Our results show that their perceived status differs from one archipelago to another, or even among islands in the same archipelago, with more positive comments (i.e. species benefits) on more isolated islands. Perception of invasiveness varied according to societal and cultural values (e.g. utilitarian or aesthetic), and often depends on the species' date of introduction ("indigenisation" of old introduced plants and animals). These surveys can provide useful baseline information on the degree to which local island communities are likely to support invasive species management, to get involved in prevention, surveillance and control efforts, and to avoid potential conflicts of interest between different stakeholders in small but sometimes complex insular societies.

Keywords: conflicts, indigenisation, invasiveness, isolation, prevention, social dimension, values

INTRODUCTION

The human or social dimension is increasingly recognised as a crucial issue for the effective management of invasive alien plants and animals (McNeely, 2000; Marshall, et al., 2011; Estévez, et al., 2014). Indeed, many control, eradication or prevention programs have been delayed or even failed because of differing public attitudes and feelings towards the targeted invasive species. The various stakeholders (such as foresters, pastoralists, horticulturists, pet shop managers, conservationists and environmentalists) may have different or opposite views of species status (e.g. "noxious/harmful" versus "useful/beneficial" species) and strong opposition by some influential groups of people or even single individuals may occur. Control or eradication programs of animals such as feral cats (*Felis catus*), feral deer (*Cervus* spp.), pigs (*Sus scrofa*), or grey squirrels (*Sciurus carolinensis*) (see references in McNeely, 2000; Estévez, et al., 2014), and of plants such as gorse (*Ulex europaeus*) in New Zealand (Hill, 1989) or strawberry guava (*Psidium cattleianum*) in the Hawaiian islands (Veitch & Clout, 2000; Warner & Kinslow, 2013) and La Réunion (Mascarene Is, Indian Ocean) are well-documented examples of social conflicts of interests, often associated with "controversies" reported in public and media opinions.

Thus, studying human perceptions and attitudes towards invasive species is often useful and sometimes an important prerequisite before starting often costly and long-term management programmes. Many recent studies have been conducted in "western" and/or well-developed regions/countries, such as Europe, Canada and USA (Bremner & Park, 2007; Garcia-Llorente, et al., 2008; Selge, et al., 2011; Fischer, et al., 2014), and New Zealand (Fraser, 2001; Russell, 2014), using questionnaires or interviews addressed to different stakeholders among different socio-professional categories. A few other studies have been conducted in developing countries where invasive species may sometimes constitute a natural resource rather than a nuisance (e.g. the potential use of water hyacinth (*Eichhornia crassipes*) as biofuel in south-east Asia, Bhattacharya & Kumar, 2010). The case of "true" island countries and territories (excluding large continental islands such as Australia, Madagascar, or Great Britain) is even less studied, although they are highly vulnerable to the impacts of invasive alien species, with many cases of native species' extinction and extirpation and stronger conservation challenges. Moreover, islands, often celebrated as natural laboratories for evolution and ecology, may also provide unique experimental grounds for societal and cultural studies, as they also harbour a high cultural diversity and different levels of socio-economic development. In this study conducted in the small tropical oceanic islands of French Polynesia (South Pacific), we tested the two following hypotheses:

Does human perception of invasive species vary with island isolation, human population and socio-economic development?

What is the influence of cultural (traditional) values on public attitudes toward introduced species in small remote islands?

MATERIAL AND METHODS

This study was conducted in French Polynesia, a European Overseas Country and Territory (OCT) located in the South Pacific, formed by about 120 small tropical oceanic islands (76 being inhabited by a total of ca. 276,000 inhabitants in 2017) divided into five archipelagos (Austral, Marquesas, Society, Tuamotu, and Gambier Is), and dispersed over a marine area as wide as Europe (Fig. 1).

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Fig. 1 French Polynesia and its 120 tropical oceanic islands located in the South Pacific. The names of the 19 surveyed small islands are underlined.

This OCT comprises both highly populated and urbanised islands (such as Tahiti, the largest with a land area of 1,045 km² and over 183,000 inhabitants) and very small isolated islands (sometimes without airstrips such as Tahaa in the Society, Fatu Iva and Tahuata in the Marquesas, Makatea in the Tuamotu, Rapa in the Austral Is with an area of only 40 km² and 515 inhabitants), which are less populated and developed, where traditional lifestyles and strong dependence on natural marine and terrestrial resources still persist. As an example, coconut plantations for copra and coconut oil production remain the main source of income in the Leeward Islands (Society), the Tuamotu atolls and the Marquesas high volcanic islands (IEOM, 2017). The island isolation or "remoteness" (distance from the most urbanised and populated island of Tahiti in km) and the number of regular flights per week departing from Tahiti or "connectivity" were used as proxies for the socio-economic development of each surveyed island.

Environmental matters and issues fall to the authorities of the French Polynesian Government, (i.e. they are different from French laws and regulation texts), with a "Code de l'Environnement de la Polynésie Française" voted by the Assembly of French Polynesia in 2003, including a chapter specifically dedicated to invasive alien species. A total of 46 species including 35 plants and 11 animals have been legally declared "a threat to biodiversity" in French Polynesia (Table 1) because of their significant negative impacts on the endemic fauna and flora. New introduction, culture or propagation, as well as inter- and intra-island transportation, of these species is banned in all islands of French Polynesia and control or eradication programmes have been set up. Their presence on each inhabited island was compiled based on literature, plant and animal databases and local expertise (Fourdrigniez, et al., 2014).

During a communication, education, prevention and capacity building campaign conducted (by the second author M.F.) between May and December 2014 (about eight months), public meetings were organised on 19 small islands (< 400 km² and 10,000 inhabitants) within 41 different villages. A total of about 2,045 people were consulted (Table 3). These meetings were held at the city halls ("mairie" in French) or community houses during the morning or the evening, and were attended mainly by adults (for a total of 1,781) and some schoolchildren.

An oral PowerPoint presentation listing and describing the 46 legally declared invasive species (38 of which were present in the surveyed small islands) was delivered, without providing details on their ecological and socio-economical impacts. Two main following questions were asked to the participants:(1) do you know or have you seen these species in your island? (2) do you consider them invasive (i.e. abundant and/or spreading) in your island, and where (i.e. which locations)?

Although no direct question was asked about species perceptions and associated values, comments were given by participants related to the negative impacts of species on biodiversity and other sectors (e.g. agriculture, health), and also their positive impacts (past and current benefits), which were systematically recorded.

RESULTS

Effects of island isolation, human population and socio-economic development

The total number of legally declared invasive alien species known to be present in each surveyed island (according to Fourdrigniez, et al., 2014) in the four archipelagos of the Leeward (Society), Austral, Marquesas and Tuamotu Is does not decrease with island remoteness (Fig. 2), comprising 44 of the 46 invasive alien species (Table 3). Invasive species diversity also does not increase with island size (Table 3) although the two largest remote islands of Hiva Oa and Nuku Hiva in the Marquesas (> 300 km² of land area) have a high proportion of species (between 50–56% of the total), probably related to their higher habitat diversity (ranging from coastal vegetation and littoral forest to dry-mesic forests, valleys and slopes rainforests, and montane cloudforests and summit ridges up to 1,200 m elevation, Lorence, et al., 2016) compared to the other surveyed islands. There is a relatively weak correlation between invasive species and the number of inhabitants (R^2=0.48, P-value < 0.01, Fig. 3a), which becomes stronger with the number of regular flights departing from Tahiti per week (R^2=0.53, P-value < 0.05, Fig. 3b), i.e. with human and goods transportation connection and frequency. This "connectivity" between Tahiti and the other French Polynesian islands constitutes a very good proxy for the socio-economic development of isolated islands. If the Tuamotu atolls are removed from the analysis, the correlation coefficient is significantly higher (R^2=0.72). Indeed, the atolls and raised atolls have fewer invasive species mainly because of their small terrestrial areas, their calcareous substrate and strong insolation

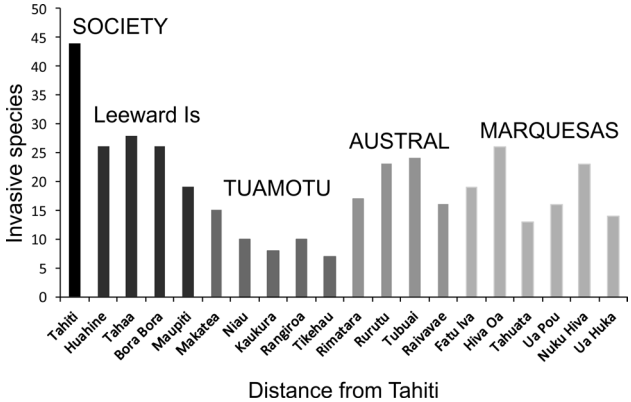

Fig. 2 Relationship between the number of invasive alien species on Tahiti and the 19 surveyed small islands according to distance from Tahiti: Leeward Is (Society Is) >170–310 km from Tahiti; Tuamotu Is >220–350 km; Austral Is >500–700 km; Marquesas Is >1,000–1,500 km (Spearman test, P-value = 0.000995).

Table 1 List of the 46 invasive alien species legally declared a "threat to biodiversity in French Polynesia" (according to the French Polynesia "Code de l'Environnement") and their presence in Tahiti and the other 19 surveyed small islands (Fourdrigniez, et al., 2014).

ANIMALS: INVERTEBRATES AND VERTEBRATES (N=11)				
Kingdom	Scientific name	Common name	Tahiti	Surveyed islands (%)
Insects	*Wasmannia auropunctata**	Little fire ant	X	0 (0%)
Molluscs	*Euglandina rosea**	Rosy wolfsnail	X	7 (36.8%)
Birds	*Acridotheres tristis**	Common myna	X	5 (26.3%)
	Bubo virginianus	Great horned owl	-	1 (5.3%)
	Circus approximans	Swamp harrier	X	4 (21.1%)
	*Pycnonotus cafer**	Red-vented bulbul	X	5 (26.3%)
Reptiles	*Trachemys scripta**	Red-eared slider	X	4 (21.1%)
Mammals	*Mus musculus**	House mouse	X	12 (63.2%)
	Rattus exulans	Pacific rat	X	19 (100%)
	Rattus norvegicus	Norway rat	X	13 (68.4%)
	*Rattus rattus**	Black rat	X	12 (63.2%)
VASCULAR PLANTS (N=35)				
Family	Scientific name (synonyms)	Habit	Tahiti	Surveyed islands (%)
Euphorbiaceae	*Antidesma bunius*	Tree	X	0 (0%)
Myrsinaceae	*Ardisia elliptica**	Small tree	X	2 (10.5%)
Moraceae	*Castilla elastica*	Tree	X	4 (21.1%)
Cecropiaceae	*Cecropia peltata**	Tree	X	6 (31.6%)
Chrysobalanaceae	*Chrysobalanus icaco*	Small tree	X	5 (26.3%)
Rubiaceae	*Cinchona pubescens**	Tree	X	0 (0%)
Hydrocharitaceae	*Egeria densa*	Aquatic herb	X	0 (0%)
Myrtaceae	*Eugenia uniflora*	Small tree	X	14 (73.7%)
Fabaceae	*Falcataria* (syn. *Albizia*) *moluccana*	Large tree	X	13 (68.4%)
Fabaceae	*Flemingia strobilifera*	Shrub	X	14 (73.7%)
Agavaceae	*Furcraea foetida*	Erect herb	X	7 (36.8%)
Crassulaceae	*Kalanchoe pinnata*	Erect herb	X	18 (94.7%)
Verbenaceae	*Lantana camara**	Shrub	X	15 (78.9%)
Fabaceae	*Leucaena leucocephala**	Small tree	X	19 (100%)
Convolvulaceae	*Merremia peltata*	Liana (woody vine)	X	8 (42.1%)
Poaceae	*Melinis minutiflora*	Grass	X	16 (84.2%)
Melsatomataceae	*Miconia calvescens**	Small tree	X	3 (15.8%)
Asteraceae	*Mikania scandens* (syn. *M. micrantha*)*	Vine	X	0 (0%)
Mimosaceae	*Mimosa diplotricha* (syn. *M. invisa*)	Shrub	X	7 (36.8%)
Passifloraceae	*Passiflora maliformis*	Liana (woody vine)	X	11 (57.9%)
Passifloraceae	*Passiflora rubra*	Vine	-	1 (5.3%)
Passifloraceae	*Passiflora suberosa*	Vine	X	2 (10.5%)
Asteraceae	*Pluchea symphytifolia*	Shrub	X	4 (21.1%)
Myrtaceae	*Psidium cattleianum**	Small tree	X	10 (52.6%)
Myrtaceae	*Rhodomyrtus tomentosa*	Small tree	X	0 (0%)
Rosaceae	*Rubus rosifolius*	Shrub	X	4 (21.1%)
Anacardiaceae	*Schinus terebinthifolius**	Tree	X	0 (0%)
Araliaceae	*Schefflera actinophylla*	Tree	X	5 (26.3%)
Bignoniaceae	*Spathodea campanulata**	Large tree	X	7 (36.8%)
Myrtaceae	*Syzygium cumini*	Tree	X	19 (100%)
Myrtaceae	*Syzygium jambos*	Tree	X	14 (73.7%)
Bignoniaceae	*Tecoma stans*	Small tree	X	9 (47.4%)
Polygonaceae	*Triplaris weigeltiana*	Large tree	X	0 (0%)
Fabaceae	*Vachelia* (syn. *Acacia*) *farnesiana*	Small tree	X	4 (21.1%)
Myrtaceae	*Waterhousea floribunda*	Tree	X	1 (5.3%)

*Listed among the "100 of the World's Worst Invasive Alien Species" (Lowe, et al., 2000).

Table 2 Number of surveyed islands, villages and people (adults) consulted during public meetings in the different archipelagos of French Polynesia.

Archipelagos	Number of surveyed islands (names)	Number of villages	No of participants (adults)
Leeward Is (Society Is)	4 (Maupiti, Tahaa, Huahine, Bora Bora)	9	494
Tuamotu Is	5 (Niau, Kaukura, Makatea, Tikehau, Rangiroa)	9	479
Austral Is	4 (Raivavae, Rimatara, Rurutu, Tubuai)	10	414
Marquesas Is	6 (Nuku Hiva, Ua Pou, Ua Huka, Hiva Oa, Fatu Iva, Tahuata)	13	394
Total	19	41	1,781

Table 3 Number and density of invasive alien species (IAS) legally declared "a threat to biodiversity in French Polynesia" in relation to geographic and demographic characteristics of islands, and plane transportation frequency or "connectivity" with Tahiti: ✈✈ island with an international airport; ✈ islands with a domestic airport or airstrip; 2012 population census (<www.ispf.pf>).

ARCHIPELAGO (distance from Tahiti in km)	Island (number of flights per week departing from Tahiti)	Area (ha)	Population (2012)	Population density (/ha)	IAS number (%)	IAS density (/ha)
SOCIETY (170-310 km)	Tahiti✈✈	104,510	183,480	1.76	44 (96%)	0.04
	Tahaa (61 via Raiatea)	9,020	5,220	0.58	28 (60.9%)	0.31
	Huahine✈ (37)	7,480	6,303	0.84	26 (56.5%)	0.35
	Bora Bora✈ (74)	2,930	9,598	3.27	26 (56.5%)	0.89
	Maupiti✈ (9)	1,140	1,223	1.07	19 (41.3%)	1.67
TUAMOTU (220-350 km)	Rangiroa✈ (20)	7,900	2,567	0.32	10 (21.8%)	0.13
	Makatea	2,950	68	0.02	15 (32.6%)	0.51
	Niau✈ (2)	2,100	226	0.11	10 (21.8%)	0.48
	Tikehau✈ (10)	2,000	529	0.26	7 (15.2%)	0.35
	Kaukura✈ (2)	1,100	475	0.43	8 (17.4%)	0.73
AUSTRAL (500-700 km)	Tubuai✈ (14)	4,500	2,170	0.48	24 (52.2%)	0.54
	Rurutu✈ (12)	3,235	2,322	0.72	23 (50%)	0.71
	Raivavae✈ (7)	2,035	940	0.46	16 (34.8%)	0.79
	Rimatara✈ (5)	953	873	0.91	17 (36.9%)	1.78
MARQUESAS (1,000-1,500 km)	Nuku Hiva✈ (15)	33,950	2,967	0.03	23 (50%)	0.07
	Hiva Oa✈ (15)	31,550	2,184	0.07	26 (56.5%)	0.08
	Ua Pou✈ (9)	10,560	2,175	0.21	16 (34.8%)	0.74
	Ua Huka✈ (6)	8,340	621	0.07	14 (30.4%)	0.17
	Fatu Iva	8,500	611	0.07	19 (41.3%)	0.22
	Tahuata	6,100	703	0.11	13 (28.3%)	0.21
TOTAL	20	250,863	222,688	0.89	46 (100%)	0.02

which constitute demanding ecological conditions for both introduced animals and plants. The Austral high volcanic islands have a cooler climate due to their southern geographical location (mean annual temperature between 18°C for Rapa Iti and 20°C for the other islands) which may also prevent the establishment and invasion of some "truly" tropical species. If the Austral islands are removed from the analysis, the correlation coefficient is slightly higher (R^2=0.57).

Perceptions of invasive species in different archipelagoos and islands

The total number of negative, positive and neutral comments (50) recorded by participants for each species was analysed for all the 19 surveyed islands. Comments were reported only for 15 of the 38 species occuring in the islands, most of them were positive (Fig. 5). More comments were made in the isolated islands of the Austral Is (> 500–700 km from Tahiti) and the Marquesas Is (> 1,000–1,500 km) with lower socio-economic development but where people seem to show a stronger interest in the use of available natural resources (Fig. 4), compared to the Leeward Is in the Society Is. Comments in the Tuamotu Is were the lowest and the number of reported invasive species is also the smallest (between 7 and 15 species, i.e. 15–33% of the total). It is noteworthy that all comments made on invasive species were positive in the Tuamotu atolls (Fig. 4), meaning they are more considered as "useful" for people than "noxious/harmful". In all surveyed islands and archipelagos, positive comments exceeded negative ones, but this rather surprising result might be biased as

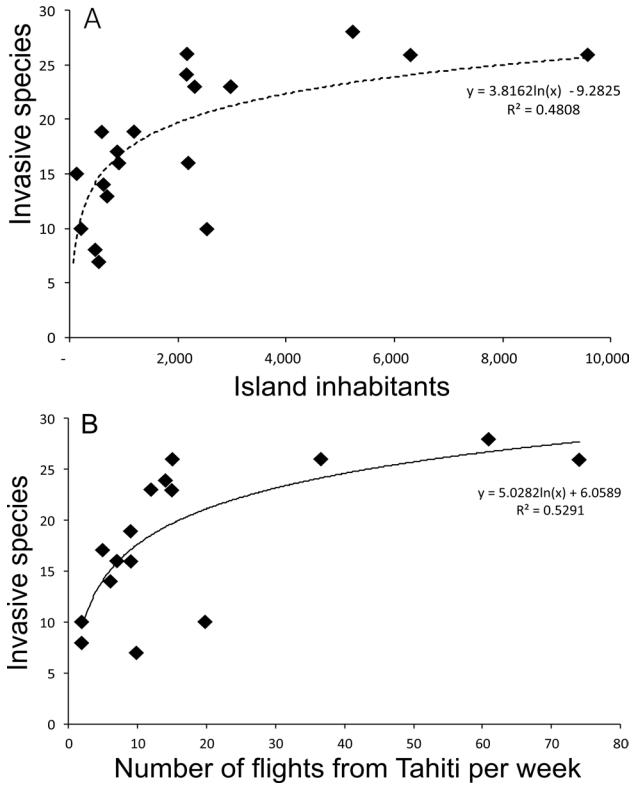

Fig. 3 A. Relationship between the number of invasive alien species and the number of inhabitants (2012 population census) in the 19 surveyed islands (Spearman test, P-value = 0.001407). B. Relationship between the number of invasive alien species and the plane transportation frequency (number of flights per week from Tahiti) in the 16 surveyed islands with a domestic airport.

most people agreeing with the invasiveness status did not make specific negative comments (e.g. for the three species of rats – *Rattus* spp.). To avoid this bias towards positive comments, future studies should explicitly ask participants for their inputs on the ecological and socio-economical impacts of the targeted invasive species.

One animal species, the common myna (*Acridotheres tristis*), has received only positive comments. This bird, first introduced to Tahiti in the early 1900s (Meyer, 2003) is indeed considered as a useful animal because it eats introduced wasps and ticks especially in the Leeward Islands of the Society archipelago (e.g. in Huahine), whereas it is subjected to an active control programme in Tahiti to protect the threatened endemic flycatcher *Pomarea nigra* (Monarchidae) (Blanvillain, et al., 2003). For vascular plants, the 29 invasive species were not considered as "noxious/harmful" in all the surveyed islands where they are present. There were many positive comments for ornamental plants or fruiting trees, especially in the most remote islands of the Austral and the Marquesas (Table 4).

It is interesting to note that the perceived status of invasive alien species differs from one archipelago to another, but also among islands in the same archipelago, such as the climbing liana *Passiflora maliformis* in the Austral Is because of its edible fruits or the large tree *Falcataria moluccana* in the Marquesas as a timber tree (Table 4). Both species are currently being controlled in areas of high conservation values in Tahiti.

DISCUSSION

Island invasibility, species invasiveness and socio-economic development

Perception of invasiveness is complex because of diverse mental representations by different key interest groups and socio-economic contexts (Garcia-Llorente, et al., 2008). An understanding of human dimensions is necessary to avoid potential social conflicts in invasive species management (Estévez, et al., 2014; Russell, 2014).

Our results conducted on small islands of French Polynesia show that the number of invasive alien species is not decreasing with island remoteness (i.e. distance from Tahiti) and island size, but is more correlated with human development (e.g. the number of inhabitants and the frequency of transportation connection with Tahiti) and habitat diversity, as documented in other islands elsewhere (Kueffer, et al., 2010). The island of Tahiti can be considered as a "transportation hub" in the South Pacific, with an international airport opened in 1960 and direct flight connections to Rarotonga (Cook Is), Australia, New Zealand, New Caledonia, California and Hawaii (USA), Chile and Japan; and a major trade port in 1962 with goods imported from Europe, North and South America and South-east Asia. The increasing development of commercial trade during the past decades (from 330,000 tons in 1989 to 980,000 tons in 2015, ISPF, 2016) was associated with a dramatic increase of accidental plant and animal introductions. Invasive insects such as fruit flies (*Bactrocera* spp., Tephrididae), the glassy-winged sharpshooter (*Homalodisca vitripennis,* Cicadellidae) and the little fire ant (*Wasmannia auropunctata,* Formicidae), first introduced to Tahiti between the 1970s and the 1990s (Meyer, 2003), have subsequently spread to many other

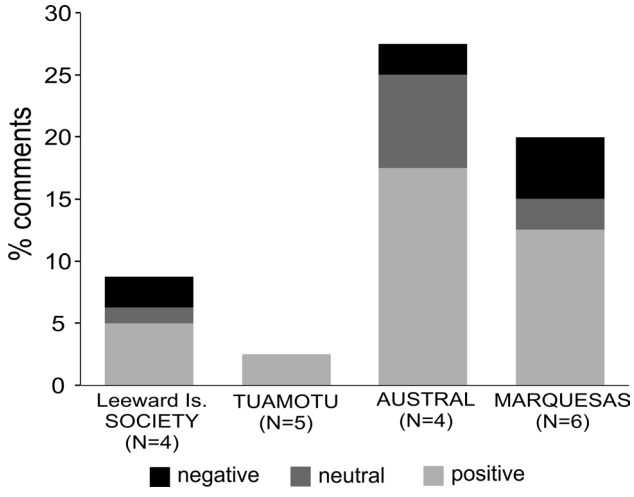

Fig. 4 Percentage of the positive, neutral and negative comments for the invasive alien species recorded in the 19 surveyed islands.

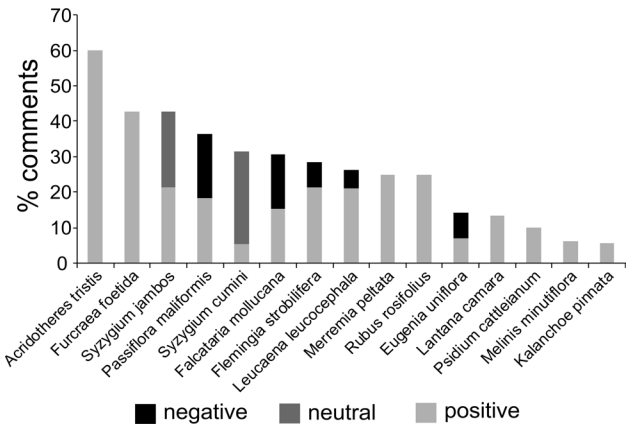

Fig. 5 Percentage of the positive, neutral and negative comments for the invasive alien species recorded in the 19 surveyed islands.

Table 4 Examples of positive and negative comments for some invasive alien plants introduced by Europeans in the surveyed islands with their date of first introduction or record in Tahiti, French Polynesia (Baas Becking, 1950; Jacquier, 1960).

Scientific name	Positive comment(s)	Island(s)	Negative comment(s)	Island(s)	Date of first introduction or record
Eugenia uniflora	Edible fruits, wood used for fish tools	Rimatara, Tubuai	Alters feral goat meat	Fatu Iva	1848
Falcataria (syn. *Albizia*) *moluccana*	Honeybee-forage plant, wood used for boats	Fatu Iva, Raivavae	Dries out rivers	Rurutu	1936
Flemingia strobilifera	Flower used in necklaces	Nuku Hiva, Ua Huka, Rimatara	Spreads in gardens	Tahuata	1937
Furcraea foetida	Formerly used for ropes & traditionnal dance skirts	Rimatara, Rurutu, Tubuai	-	-	?
Lantana camara	Ornamental garden plant	Nuku Hiva, Ua Huka	-	-	1853
Leucaena leucocephala	Forage for cattle, improves soil erosion control	Nuku Hiva Ua Huka	-	-	1845
Passiflora maliformis	Edible fruits used for jams	Rimatara	Suppresses orange and coffee trees	Fatu Iva, Tubuai	?
Syzygium cumini	Edible fruits	Tikehau, Makatea	-	-	1880
Syzygium jambos	Edible fruits	Tubuai			1890

French Polynesian islands through inter-island boat and/or plane transportation.

The perceived status of the 46 legally declared invasive species, a small subset of the total number of invasive species in French Polynesia (e.g. with more than 80 plants considered as invasive, Fourdrigniez & Meyer, 2008), differs from one archipelago to another, or even among islands in the same archipelago. They are more positively considered in the most isolated islands with lower socio-economic development and/or where natural resources are extremely limited, e.g. in atolls where invasive woody plants are used as tools or for wood construction, such as *Leucaena leucocephala*. This is very similar to the different attitudes of urban *versus* rural residents to pest species management in western developed countries or in Australia and New Zealand in the Pacific region (Fraser, 2001; Johnston & Marks, 1997). When abundant, invasive alien species are often seen as potential natural resources by islanders whereas when they are less common or rare, people agreed to eradicate introduced species. Species prioritisation that includes socio-economic values may thus contribute to a better efficiency in control or eradication by gaining support of local communities in remote islands.

Importance of cultural values

Human perceptions and attitudes vary with time, places, societies, economic conditions and culture (Dalla Bernardina, 2010; Fitzgerald, et al., 2007). The importance of cultural (traditional or ancestral) values of introduced species in the Pacific islands is well illustrated by animal species that were introduced by the first humans during their migration and colonisation, and became invasive with time, with sometimes dramatic impacts on the native biodiversity. Feral pigs (*Sus scrofa*) are still a source of dispute between conservationists and native Hawaiians who hunt them as in the past (Van Driesche & Simberloff, 2016), and Pacific rats (*Rattus exulans*) are considered a treasure brought to New Zealand by their Maori ancestors, thus may be worshipped and of high significance (Haami, 1994; Veitch & Clout, 2000). Some plants introduced by the first Polynesians for ritual, aesthetic or utilitarian values (Whistler, 2009) have also spread into native lowland forests in French Polynesia and Hawaii, including the candlenut tree (*Aleurites moluccana,* Euphorbiaceae) and the bamboo (*Schizostachyum glaucifolium,* Poaceae) where they are considered as either invasive (Smith, 1985) or part of the Polynesian social heritage (Larrue, et al., 2010).

Our survey indicates that the date of species introduction in the islands of French Polynesia, more particularly in Tahiti (Baas Becking, 1950; Jacquier, 1960), seems to be an important factor explaining attitudinal differences, as old introduced species seem to be more widely accepted or positively considered by people, because of their long co-existence (more than one century). This is the case of the small tree *Leucaena leucocephala* and the shrub *Lantana camara* which were introduced by Europeans in French Polynesia in 1845 as a fodder plant and 1853 as an ornamental garden plant respectively, and often still considered as beneficial species (Table 4). This phenomenon is sometimes, but incorrectly, called "indigenisation", as these naturalised species ("naturalisation" is defined as an ecological proces where the alien plant species establishes and becomes incorporated within the natural flora, Richardson, et al., 2000) are not becoming indigenous or native but part of the human culture or natural heritage. It should be refered to as "heritagisation" ("patrimonialisation" in French) which describes a socio-cultural, legal or political process where an area, a good or a species is transformed into an object of the natural, cultural or religious heritage with conservation or restoration value.

One of the crucial challenges in invasive species management is the active involvement, engagement and support of local communities (Hart & Larson, 2014), as well as resolving or at least avoiding potential conflicts of interest between different stakeholders. The small Pacific islands, including French Polynesia, provide an excellent ground for testing new methodologies and initiatives in complex insular societies. Based on the results of this survey, we propose that an "invasive species perception

index" should be included in feasibility studies to manage biological invasions in isolated inhabited islands.

A first step to integrate the local socio-economic and cultural dimensions of invasive species in the islands of French Polynesia was the creation of a network during and following this survey (called "Te Rau Mata Arai" in Tahitian, literally the "numerous watchful eyes"). Its aims are the prevention, detection, surveillance and control of invasive alien species by identifiying local, key people in each island (a total of 36 on the 19 surveyed islands) including local government and city council representatives, members of nature protection groups, small entrepreneurs, and other civil society actors.

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