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Beasts or beauties? Laypersons' perception of invasive alien plant species in Switzerland and attitudes towards their management

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Abstract

This study investigated laypersons' perception of invasive alien plant species (IAPS) and attitudes towards their management with the help of a written questionnaire in the cities of Zurich, Geneva, and Lugano, Switzerland. Survey participants (n = 720) judged attractiveness from certain species on visual contact (eight IAPS were shown as photographs). *Trachycarpus fortunei* and *Ludwigia grandiflora* were liked most, while *Ambrosia artemisiifolia* was clearly disliked most. With the exception of *Trachycarpus fortunei*, all plant species were perceived as rather ordinary, familiar and native to Switzerland, and feelings of ordinariness, familiarity and nativeness were positively correlated. Few participants could correctly identify the species depicted. Knowledge of an IAPS (ability to identify it) and desire to have it around were negatively correlated. Participants agreed most with the eradication of IAPS that cause serious costs and problems. However, people were rather unwilling to remove *Buddleja davidii*, *Solidago canadensis*, and *Trachycarpus fortunei* which are already widely established ornamentals in settlement areas or gardens. Overall, willingness to remove an IAPS and to report it to the authorities decreased with increasing desirability (and thus beauty) of a species.

Keywords

Invasive alien plant species, Switzerland, public perception, public attitudes, management

Introduction

Invasive alien species (IAS) are often considered a major threat to the world's biodiversity (MEA 2005, Vilà et al. 2011, Simberloff et al. 2013). They occur in all taxonomic groups and can affect all types of ecosystems (CBD 2009). IAS can be defined as species which establish outside their natural past range and dispersal potential and, once established, rapidly extend their range in the new region, causing significant harm to biological diversity, ecosystem functioning, socio-economic values, and/or human health in the invaded region (Vilà et al. 2011, Hulme et al. 2013). The strong increase in human travel, trade, and transportation has led to the introduction of many species to areas where they would not have been present without human assistance (Keller et al. 2011). As humans take an active part in the introduction, establishment, and spread of IAS, it is necessary to understand human perceptions and choices regarding the use and management of invasive species (Bardsley and Edwards-Jones 2007). However, research on biological invasions has focused more often on the ecological aspects of IAS than on social perceptions and attitudes of people (but see, e.g., García-Llorente et al. 2008, Andreu et al. 2009, Selge et al. 2011, Sharp et al. 2011, van der Wal et al. 2015). The present study is one of the first to investigate laypersons' perception of invasive alien plant species (IAPS) and attitudes towards their management in Switzerland.

Designing policies which prevent the introduction and release of IAS, and the management of species already established have become priority goals in many European countries (Commission of the European Communities 2008). About ten years ago, the Swiss Federal Office for the Environment (FOEN) commissioned an inventory of alien species in its country (Wittenberg 2005). Similar to other Central European countries, the assessment came up with about 800 alien species. Most of the aquatics and terrestrial invertebrates and diseases were accidental arrivals, whereas most of the vertebrates and plants were deliberate introductions. Plant species introduced as ornamentals are by far the largest group worldwide from which potential invasive ones emerge (Mack 2001). In Switzerland, for instance, 15 of the 23 IAPS on the Black List[1] have been deliberately introduced as ornamentals (Wittenberg 2005). However, as they cause substantial damage, prevention, control, and eradication measures are needed.

The general public's support and participation can be a key to success or failure of prevention, control, and eradication measures regarding IAS (Bertolino and Genovesi 2003, Bremner and Park 2007). However, the public's knowledge about IAS may be very limited. Several studies indicate that laypersons, at least in highly industrialized countries, know little about (local) plant and animal species, their diversity, and their ecological importance (e.g., Hunter and Brehm 2003, Pilgrim et al. 2007, Lindemann-Matthies and Bose 2008). Moreover, the discussion about IAS management and species conservation often neglects values which people attach to certain organisms (overview in

[1] The "Black List" includes invasive alien plants of Switzerland that cause damage in the areas of biodiversity, health, and/or economy. The establishment and the spread of these species must be prevented (FOEN 2007).

Heink and Jax 2014). Perceptions of laypersons on species conservation might strongly differ from those of ardent conservationists and natural resource managers, especially when the lethal removal of charismatic mammals is discussed (Minteer and Collins 2005, Lundberg 2010). However, laypersons might also not support the removal of "beautiful" IAPS, i.e., plants which are typically used as ornamentals (Veitch and Clout 2001, Lindemann-Matthies 2005). They might be perceived as a local enrichment to cities, gardens, banquettes, and even industrial zones (McKinney 2006). In consequence, public attention might be drawn away from problems related to the invasiveness of certain species. It is therefore important to know how people perceive and respond to IAS, as this facilitates the design of environmental management policies and communication strategies that are more likely to find acceptance among the general public (Fischer and van der Wal 2006).

This study investigated the perception of IAPS by more than 700 laypersons in Switzerland and their attitudes towards species management. The study contributes to international research on public perception of IAS and attitudes towards management strategies (e.g., Fischer and van der Wal 2006, Bremner and Park 2007, García-Llorente et al. 2008, Sharp et al. 2011), on stakeholders' perception of alien plant species in Switzerland (Humair et al. 2014a), and, more generally, on biodiversity perception (e.g., Colton and Alpert 1998, Fischer and Young 2007, Lindemann-Matthies and Bose 2008). It also provides baseline data for conservation activities that build upon the existing perceptions and attitudes of laypersons in Switzerland.

Main objectives were to investigate laypersons' (1) characterization of eight IAPS shown on paper, (2) ability to identify them, and (3) attitudes towards certain types of management. It was also investigated whether laypersons' perception of IAPS and attitudes towards certain types of management were influenced by socio-demographic variables and study location.

Methods

Study design and data collection

The study was carried out in three cities Zurich, Geneva, and Lugano, which are situated in three different regions and cantons (= administrative divisions) of Switzerland. Zurich in the north of the country belongs to the canton of Zurich (German-speaking part of Switzerland), Geneva in the southwest to the canton of Geneva (French-speaking part), and Lugano in the very south to the canton of Ticino (Italian-speaking part). Data were collected at the lake-sides of the three cities, as people are likely to be there during leisure time, and willing to take their time to answer the questions. Randomly selected passers-by (18 years and older) were asked, always in a similar way, to participate in a study about plants. In summer 2009, 720 persons filled out the questionnaire (240 in each city) in the local language. Data collection exercises required approximately 15 minutes time, and anonymity was guaranteed to the participants.

Questionnaire approach

The questionnaire consisted of two parts, which were printed on two separate sheets of paper to avoid influences of the second part, in which information about IAPS was provided, on the first part (Suppl. material 2). Participants were instructed to ask for the second sheet after finishing the first one. The first part investigated laypersons' perception of eight IAPS and their ability to identify them (objectives 1 and 2). Seven of these species were on the Black List (*Ambrosia artemisiifolia*, *Buddleja davidii*, *Heracleum mantegazzianum*, *Impatiens glandulifera*, *Ludwigia grandiflora*, *Senecio inaequidens*, and *Solidago canadensis*) and one was on the Watch List (*Trachycarpus fortunei*). Species were chosen by impact (*A. artemisiifolia*, *H. mantegazzianum* and *I. glandulifera* are among the 100 worst alien terrestrial plant species in Europe (http://www.europe-aliens.org/speciesTheWorst.do)), popularity (*B. davidii* and *S. canadensis* are typical garden plants), threats to human health (*H. mantegazzianum* produces sap that causes skin lesions upon contact and pollen of *A. artemisiifolia* is highly allergenic), and regional importance, e.g., *S. canadensis* in Zurich, *L. grandiflora* in Geneva and *T. fortunei* in Lugano (FOEN 2006). Moreover, *A. artemisiifolia*, *H. mantegazzianum*, *I. glandulifera*, *L. grandiflora*, *S. inaequidens*, and *S. canadensis* are included in the "Swiss Ordonnance on Organism Dissemination in the Environment (ODE) RS 814.911" (2008) and may therefore not be introduced into the environment in Switzerland.

All plants were presented as photographs and their invasive status was not revealed. Each species had to be characterized by five opposing attributes (ugly-beautiful, extraordinary-ordinary, exotic-indigenous, unfamiliar-familiar, unwanted-wanted) on 7-step scales (e.g., very ugly, ugly, rather ugly, neither/nor, rather beautiful, beautiful, very beautiful). After the characterization exercise, participants had to identify as many species as they could and write down their common names. A plant was regarded as correctly identified if its common name was provided at the genus or species level.

The second part investigated laypersons' attitudes towards different types of management (objective 3). A short introduction provided information about IAPS and also clarified that all species shown in the first part were invasive. Participants had to choose among four different types of management (no intervention, no removal of aesthetically pleasing plants, but removal of less appealing ones, removal of only those invasive plants that provoke serious problems and costs, removal of all invasive plants in order to conserve unique habitats and species) to find the one type of management they considered most suitable. To investigate whether the choice of a certain management type depends on the species involved, a brief portrait of one of the IAPS used in the picture test was included in each questionnaire. Eight different versions of the second questionnaire part were thus prepared (varying in portraits, but being otherwise identical). The questionnaires were handed out to the 240 participants (30 persons per version) in each city which overall amounted to 720 questionnaires being filled out. Participants had to select among three types of management (no intervention, surveillance without taking immediate action, removal), and choose the one they considered

to be most fitting for the IAPS presented. In case they had chosen the latter type, they were asked where the species should be removed (from nature reserves, natural areas, forests or farmland, settlement areas, cities, and gardens). Moreover, they were asked whether they would report the species if they detected it, and whether they would remove it from their own garden.

Finally, participants were asked about their age, sex, level of formal education, professional expertise (profession related to biology, ecology or landscape topics), and environmental commitment (membership in an environmental organization). These variables were found influential in studies on biodiversity perception (e.g., Lindemann-Matthies and Bose 2008, Junge et al. 2011), and on attitudes towards invasive species (e.g., Fischer and van der Wal 2006, Bremner and Park 2007, García-Llorente et al. 2008).

Participants and data analysis

Participants (52% women) were between 18 and 79 years old (mean age = 32 years). About 68% of participants had a high school degree, 9% a profession related to biology, ecology, or landscape topics, and 22% were members in an environmental organization. Similar numbers were found in a large representative Swiss study on landscape perception (Junge et al. 2011).

Linear regressions were used to test for influences of socio-demographic variables and study location on participants' characterizations of eight IAPS and number of IAPS correctly identified. The final minimum adequate models were obtained by backward elimination of non-significant ($p > 0.05$) variables. As this type of analysis does not allow strong correlations between explanatory variables ($r > 0.35$), Pearson correlations between binomial and metric explanatory variables were tested first (Crawley 2005). The following variables and factors were initially included in the models: age, sex, level of education (high-school degree or not), professional experience (profession related to biology/ecology/landscape topics or not), environmental commitment (membership in an environmental organization or not), and study location (dummy coded with Geneva and Lugano tested versus Zurich).

Ordinal regression was used to test for influences on participants' attitudes towards certain types of management (as outlined in Figure 2). The four different types were reduced to three, i.e., no intervention, partial intervention (combination of answers "removal of IASP that provoke serious problems and costs" and "removal of aesthetically less appealing ones") and total removal of IAPS, and treated as an ordered dependent variable (from low to high intervention intensity). The following variables and factors were initially included in the model: age, sex, level of education, professional experience, environmental commitment, study location (dummy coded), and "taxonomic knowledge" (number of species correctly identified). All analyses were carried out with SPSS for Windows 20.0.

Results

Characterization of eight IAPS (objective 1)

Almost all plants were perceived as beautiful and wanted. On average, *Ludwigia grandiflora* was considered most beautiful, *Trachycarpus fortunei* most extraordinary, exotic and wanted, *Senecio inaequidens* most ordinary, indigenous and familiar, *Solidago canadensis* most unfamiliar, and *Ambrosia artemisiifolia* most ugly and unwanted (Figure 1). Aesthetic appeal and desirability of a species (attributed scores on the "ugly-beautiful" and "unwanted-wanted" scale, respectively) were positively correlated as were perceived nativeness, familiarity and ordinariness (scores on the "exotic-indigenous", "unfamiliar-familiar" and "extraordinary-ordinary" scale, all correlation coefficients between 0.15 and 0.46, all $p < 0.001$). Moreover, perceived nativeness and desirability (scores on the "exotic-indigenous" and "unwanted-wanted" scale) were positively correlated (all correlation coefficients between 0.14 and 0.22, all $p < 0.002$). Only in case of *T. fortunei*, no significant correlation was found between nativeness and familiarity or nativeness and desirability ($p > 0.906$).

Study location influenced characterizations (Table 1, see Figure 1). Compared with Zurich, most plant species were less wanted by participants in Lugano, and some also less wanted by participants in Geneva. Moreover, several plants were considered more ordinary, but less indigenous in Lugano than in the other two locations (especially *T. fortunei*). Age especially influenced how beautiful and extraordinary a plant was perceived to be (see Table 1). Sex-related differences were always due to higher ratings by women (on the 7-step scales), and occurred especially in case of beauty and familiarity. Level of formal education and professional expertise hardly influenced ratings, while environmental organization members considered *L. grandiflora*, *H. mantegazzianum* and *I. glandulifera* less extraordinary, and the latter two also more indigenous than did non-members.

Identification of the eight IAPS (objective 2)

Only 75 participants could correctly identify at least one of the plant species presented (1 species: 41 persons, 2–3 species: 27 persons, 4–7 species: 7 persons, 8 species: nobody). *B. davidii* and *H. mantegazzianum* were most often and *S. inaequidens* and *L. grandiflora* least often correctly identified (see numbers in brackets in Table 2).

In the model ($r^2 = 0.16$), age, professional experience, membership in an environmental organization and study location influenced participants' "taxonomic" knowledge. With increasing age, individuals were more able to identify species correctly ($b = 0.01$, $t = 6.29$, $p < 0.001$), as were participants with professional expertise ($b = 0.39$, $t = 4.54$, $p < 0.001$) and environmental organization members ($b = 0.23$, $t = 3.74$, $p < 0.001$). Participants in Lugano were less able than the others to identify species correctly ($b = -0.16$, $t = -3.08$, $p = 0.002$).

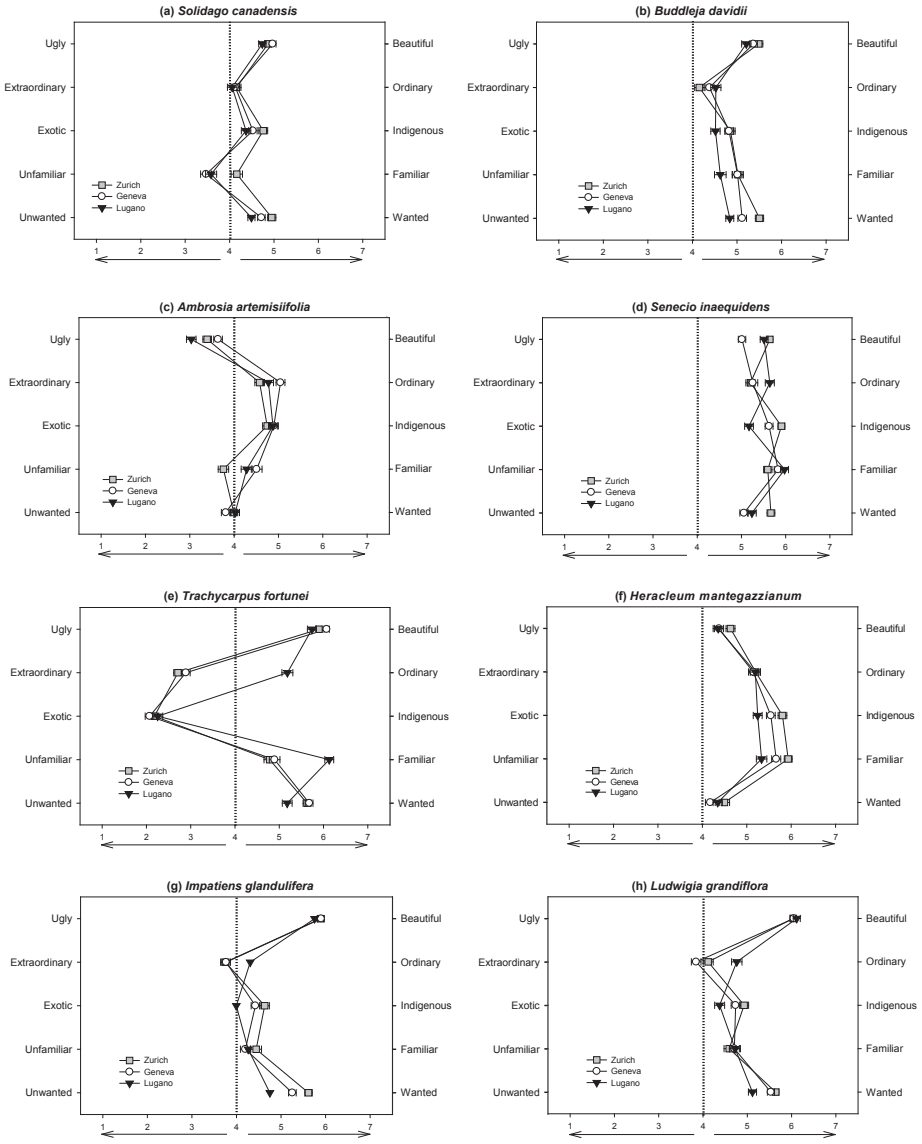

Figure 1. Characterization of eight invasive alien plant species in Zurich, Geneva and Lugano. Participants (n = 720) had to characterize each species by five opposing attributes (ugly-beautiful, extraordinary-ordinary, exotic-indigenous, unfamiliar-familiar, unwanted-wanted) on 7-step scales (e.g., very ugly, ugly, rather ugly, neither/nor, rather beautiful, beautiful, very beautiful). Mean rating scores and standard errors of means are shown.

Knowledge of an IAPS (ability to identify it on paper) and desire to have it around (attributed score on the "unwanted-wanted" scale) were negatively correlated. An IAPS was considered (rather) unwanted by those participants who knew it, and (rather) wanted by those who did not. Only with *B. davidii* was this not the case (see Table 2).

Table 1. Influence of socio-demographic variables and study location on laypersons' (n = 720) characterization of eight invasive alien plant species of Switzerland that were shown to them on photos. All characterizations were done with the help of 7-step rating scales, anchored on both sites with five dichotomous attributes (e.g., very ugly-very beautiful; see Figure 1). Data were analyzed by multiple regressions (backward selection). Only significant effects (t- and p-values) are shown (*: $p < 0.05$; **: $p < 0.01$; ***: $p < 0.001$). P-values were adjusted by Bonferroni-correction for multiple testing.

Attributes and species	Age	Women vs. men	Prof. related to ecology	NGO member	Geneva vs. Zurich	Lugano vs. Zurich
Beautiful						
S. canadensis	6.11***					
B. davidii	3.09*	4.56***	3.01*			
A. artemisiifolia	6.53***				3.27*	
S. inaequidens	2.87*	2.97*			-5.95***	
H. mantegazzianum	4.45***	3.19**				
I. glandulifera		3.25**				
L. grandiflora		3.31**				
Ordinary						
B. davidii			2.97*			
S. inaequidens	-4.38***					
T. fortunei	-2.78*					17.88***
H. mantegazzianum				-2.84*		
I. glandulifera				-2.99*		4.14***
L. grandiflora	-3.09*					5.06***
Indigenous						
B. davidii		3.84***				
S. inaequidens						-5.51***
H. mantegazzianum				3.42*		-3.63***
I. glandulifera	3.33**					-3.87***
L. grandiflora						-3.51***
Familiar						
S. canadensis	3.98***				-3.77***	
B. davidii		4.52***	5.54***			
A. artemisiifolia					4.38***	3.07*
T. fortunei		3.20*		2.83*		9.12***
H. mantegazzianum		3.59***	3.38**			-3.81***
I. glandulifera	4.53***					
L. grandiflora		3.03*				
Wanted						
S. canadensis	3.30**					-2.76*
B. davidii		3.56***			-2.90*	-5.06***
S. inaequidens	3.66***				-4.50***	
T. fortunei						-4.07***
I. glandulifera		3.80***			-3.00*	-7.08***
L. grandiflora						-4.68***

Table 2. Relationship between knowledge of IAPS (measured as the ability to identify them) and degree of their desirability (measured on a 7-step scale with 1: very unwanted, 2: unwanted; 3: rather unwanted; 4: neither unwanted nor wanted; 5: rather wanted, 6: wanted, 7: very wanted). The number of participants (overall 720 persons) who could correctly identify the species is shown in brackets. Data were analyzed only when more than ten participants could identify the species. *: $p < 0.05$; **: $p < 0.01$; ***: $p < 0.001$.

Species	Desirability (mean rating scores)		Test statistics	
	Unable to identify	Able to identify	F-value	P-value
Solidago canadensis	4.7 ± 0.05	4.0 ± 0.27 (25)	6.76	0.009
Buddleja davidii	5.2 ± 0.06	5.1 ± 0.20 (51)	0.08	0.781
Ambrosia artemisiifolia	4.0 ± 0.06	2.1 ± 0.33 (19)	31.45	<0.001
Senecio inaequidens	5.3 ± 0.06	2.0 (1)	-	-
Trachycarpus fortunei	5.5 ± 0.06	3.2 ± 0.60 (6)	-	-
Heracleum mantegazzianum	4.4 ± 0.07	3.6 ± 0.32 (28)	5.38	0.021
Impatiens glandulifera	5.2 ± 0.05	3.2 ± 0.45 (9)	-	-
Ludwigia grandiflora	5.4 ± 0.05	2.5 ± 0.91 (2)	-	-

Opinion on types of management (objective 3)

In view of participants, for IAPS that cause serious costs and problems, removal was clearly the best type of management and thus most often chosen (Figure 2). Results of the ordinal regression analysis showed that only "taxonomic" knowledge (number of IAPS correctly identified) significantly influenced a person's decision for a certain type of management. With increasing knowledge, the likelihood increased that one of the stricter types of management (partial or total removal of IAPS) was opted for (Wald = 12.73, $p < 0.001$).

When asked how to proceed with the individual species presented in the second questionnaire sheet, participants more often opted for removal than surveillance, only with *T. fortunei* and *B. davidii* was this not the case (Figure 3).

Participants who had opted for the removal of a species were asked where they wanted a species to be removed. Especially in case of *S. canadensis*, *B. davidii*, *T. fortunei* and *I. glandulifera*, a removal from nature reserves, natural areas and forests or farmland received more support than one from settlement areas, cities, and gardens (Table 3). In case of *A. artemisiifolia* and *H. mantegazzianum*, however, a removal from participants' own gardens was indicated most often, although participants were not sure that they would actually recognize these two species. Relatively few participants would announce IAPS to the authorities, especially not *B. davidii* and *T. fortunei*.

The overall determination to remove an IAPS from the environment (mean proportion of agreement to removal of species in the seven locations, see Table 3) was negatively correlated to its attributed desirability (mean score per species on the unwanted-wanted scale). With increasing desirability (and thus beauty) of an IAPS, the proportion of agreement to remove it from the environment decreased ($r = -0.75$, p

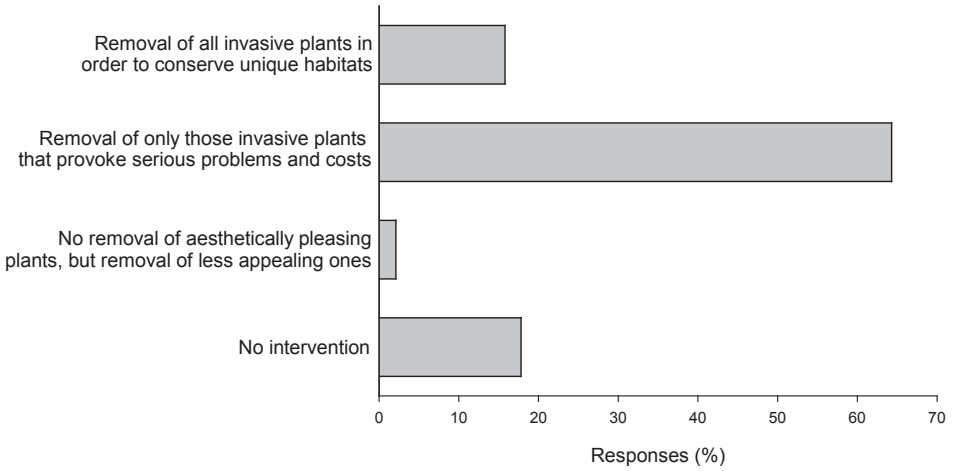

Figure 2. Preference for certain types of management in Zurich, Geneva and Lugano. Participants (n = 720) had to choose among four management types the one they considered most suitable.

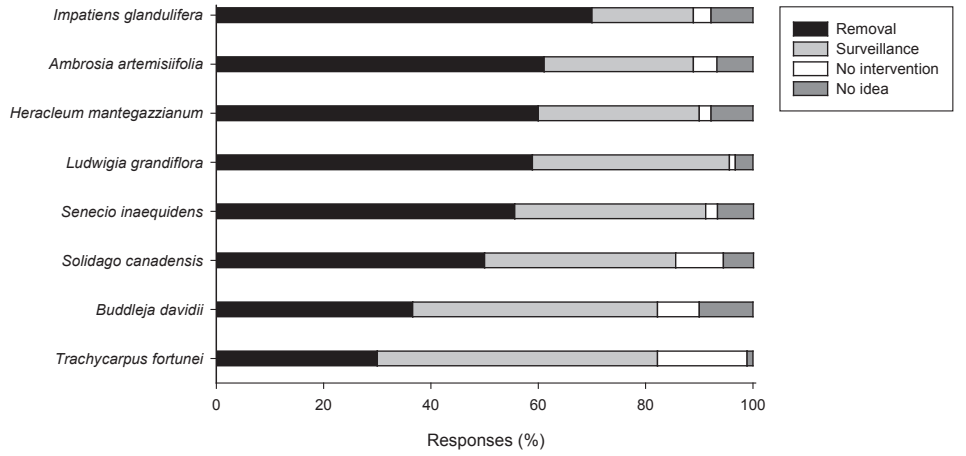

Figure 3. Proportion of people choosing various types of management for eight invasive alien plant species. Each species was introduced to 90 participants who then had to select the one type they considered most suitable for the species presented.

= 0.034). Analyzed separately, with increasing desirability of an IAPS, agreement to its removal from settlement areas (r = -0.85, p = 0.034), cities (r = -0.81, p = 0.015), gardens (r = -0.76, p = 0.029) and own gardens (r = -0.71, p = 0.048) decreased. Desirability and willingness to report an IAPS to the authorities were negatively correlated (r = -0.76, p = 0.029).

Table 3. Willingness of participants to remove IAPS in certain locations and to report these species to the authorities. Only participants who had previously opted for a removal of these species in Switzerland (numbers provided in brackets) were included.

Species	Removal of species (agreement in %)								Reporting of species (%)		
	Nature reserves	Natural areas	Forests or farmland	Settlement areas	Cities	Gardens	Own garden	Overall mean	Yes	No	Not sure to recognize it
Solidago canadensis (n = 45)	**75.6**	66.7	60.0	24.4	20.0	24.4	64.4	47,9	22.2	31.1	46.7
Buddleja davidii (n = 33)	**69.7**	60.6	39.4	24.2	27.3	27.3	45.5	42,0	15.2	54.5	30.3
Ambrosia artemisiifolia (n = 55)	52.7	45.5	58.2	**76.4**	69.1	63.6	85.5	64,4	25.5	25.5	49.0
Senecio inaequidens (n = 50)	54.0	58.0	66.0	36.0	30.0	46.0	**78.0**	52,6	14.0	30.0	56.0
Trachycarpus fortunei (n = 27)	59.3	**70.4**	55.6	11.1	14.8	18.5	33.3	37,6	18.5	48.1	33.4
Heracleum mantegazzianum (n = 54)	66.7	63.0	46.3	53.7	37.0	55.6	**87.0**	58,5	31.5	20.4	48.1
Impatiens glandulifera (n = 63)	**68.3**	**68.3**	55.6	19.0	14.3	17.5	54.0	42,4	17.5	36.5	46.0
Ludwigia grandiflora (n = 53)	**77.4**	67.9	64.2	39.6	35.8	37.7	60.4	54,7	20.8	34.0	45.2

Discussion

Almost all plants were perceived as beautiful and wanted (first part of the questionnaire). Moreover, perceived beauty and desirability (high scores on the "beautiful" and "wanted" side of the rating scales) were positively correlated. It should be noted that participants' characterizations were unaffected by information about the invasive status of these species, this information was provided only in the second part of the questionnaire. As most participants did not recognize the species presented anyway, the results reflect unbiased feelings and preferences. Encounters with IAPS might thus evoke pleasurable (aesthetic) feelings, at least in laypersons, and a desire to keep them where they are. Participants' aesthetic feelings were hardly influenced by education or expertise, but were more prominent in women and increased with age. Women are generally more in favor than men of visually appealing plants (Strumse 1996, Lindemann-Matthies and Bose 2007), while older people might have developed a gardener's view on plants. Experiences with plants through garden work or other leisure-time activities are likely to increase with age, which might find their expressions in stronger feelings for the beauty and uniqueness of plants - even when it comes to *Ambrosia artemisiifolia*. This might also explain the increase in "taxonomic" knowledge with age.

Plants with bright flower colors, large sizes, and fragrance were found to be highly attractive to humans (Mack 2001, Lindemann-Matthies 2005, Lindemann-Matthies and Bose 2007). A preference for showy flowers was also evident in the present study. *Ludwigia grandiflora*, the largeflower (sic) primrose-willow, with its single large yellow flower was considered most beautiful and wanted, while *Ambrosia artemisiifolia* with its inconspicuous appearance was considered most ugly and unwanted. On several Mediterranean islands, the widespread invasive Bermuda buttercup (*Oxalis pes-caprae*), an herbaceous annual plant, was also perceived as highly attractive for its yellow flowers and many people were surprised that it was not a native species (Bardsley and Edwards-Jones 2007).

With exception of the Chinese windmill palm (*Trachycarpus fortunei*), all species were perceived as rather ordinary, familiar and indigenous. Feelings of familiarity, ordinariness and nativeness were positively correlated. Such feelings paired with a lack in "taxonomic" knowledge might severely bias laypersons' perception of IAPS. Perceived familiarity with an IAPS has been found to have a mitigating effect on risk perception, and perceptions of risk increased if a species was perceived to be non-native (Humair et al. 2014b). Inexperienced laypersons may also be victims of a confusing use of terms. Alien species are often called "exotic", "foreign" or "introduced" (see McNeely 2001, p. 3, Colautti and MacIsaac 2004). In consequence, laypersons might expect IAPS to be exactly like that: exotic in appearance like the Chinese windmill palm. However, it should be noted that in Lugano, compared to the other two places, several plant species, and especially *T. fortunei*, were considered more ordinary, familiar, and less wanted (although still strongly on the "wanted" side of the scale). This reflects reality as *T. fortunei* is indeed common in the Ticino (FOEN 2006), and also indicates that despite their obvious lack of "taxonomic" knowledge, participants in Lugano had a feeling for IAPS in their environment.

Level of formal education did not influence participants' attitudes towards certain management types (but see Fischer and van der Wal 2006, García-Llorente et al. 2008), while knowledge of IAPS did. Participants who were able to identify IAPS from photos and might thus be able to recognize them outdoors, considered these species much more unwanted than those who were not. Correspondingly, support for a total removal of IAPS was much higher among "taxonomic experts", who were significantly more often individuals with a profession related to biology/ecology or landscape planning and members in an environmental organization. Due to their (professional) expertise and interest in environmental issues, they might know more about IAPS, be more sensitized about their negative impacts, and thus react accordingly in their choice of management types.

Participants agreed most with the proposal to eradicate only IAPS that cause serious problems and costs. A preference for the eradication of only economically damaging species instead of eradication of all IAS was also found in other studies (Bardsley and Edward-Jones 2007, Bremner and Park 2007, García-Llorente et al. 2008). This result was thus not unexpected and may reflect a greater concern of the public for the negative economic rather than ecological effects of IAPS. In case of *A. artemisiifolia* and *H. mantegazzianum*, agreement for species removal in almost all locations was high (note that this was the case after information about these species was presented). This supports the notion that it is not the threat to the environment, but the threat to the well-being of people that is of central concern in the invasive plant discussion (Fransson and Gärling 1999). However, when it came to attractive and already widely established ornamentals such as *B. davidii*, *S. canadensis* and *T. fortunei*, participants were much less willing to remove these species from settlement areas or gardens. Overall, willingness to remove an IAPS and to report it to the authorities decreased with increasing desirability (and thus beauty) of a species. This indicates that laypersons, even when they have information about IAPS and the problems they can cause, still think that the beauty of some invasive plants may in settlement areas more than outweigh the damage they may cause. In other words: beauties do not easily become beasts.

As seen in this study, invasive species management might get in conflict with a public unwilling to support eradication of appealing plants. *Ludwigia grandiflora* and *Trachycarpus fortunei* (both with strong invasive potential in Switzerland, e.g., Walther et al. 2007, Nehring and Kolthoff 2011) were perceived as beautiful and wanted. However, taxonomic knowledge of these (and other) species diminished the wish to have them around. In contrast to the above mentioned species, *Ambrosia artemisiifolia* was already perceived as rather ugly and unwanted. Nevertheless, there is also no reason to hope that populations of ragweed will be detected, reported to the authorities, or eradicated by laypersons as only few persons knew what the species actually looks like.

There are certain limitations to the present study. Younger people were over-represented as they were much more willing to participate than older ones. Moreover, higher qualified and environmentally engaged individuals were also overrepresented. Similar results were found in other comparable studies (e.g., Colton and Alpert 1998, Bremner and Park 2007). Participants are thus a convenience sample, and results can-

not be generalized to the public in Switzerland. In the questionnaire, participants' perceptions of the eight IAPS were examined with conceptually-related attributes using semantic differentials. The positive correlations between, e.g., aesthetic appeal and desirability of a species as well as between familiarity and nativeness could thus be due to overlaps of these concepts. However, these characteristics covered a spectrum of relevant attributes used in the discussion about IAS and in previous research (e.g., Fischer and van der Wal 2007). In the description of the eight invasive plant species (Suppl. material 1), negative effects of the invasive species were explained to the participants. This information may have influenced participants' choice of certain types of management, but was considered to be necessary background information for laypersons.

Conclusions

Public support is seen as crucial for the prevention and successful management of IAS in Switzerland (Wittenberg 2005). The present results highlight the importance of understanding the values and attitudes held by the general public with respect to IAS management support (see also Bremner and Park 2007). Participants' intuitive perception of the eight IAPS presented was one of "desirable native (or in case of *T. fortunei* exotic) beauties". Taking into account that only few participants had prior knowledge of IAPS due to their profession or personal interest, the results exemplify the need to help laypersons understand the threats (beautiful) IAPS can pose. Otherwise, they may question and rather not support eradication or control programmes, especially of species that are considered attractive.

The present results also highlight that public information should focus more on impact-related criteria of IAPS than on species' origin (see also van der Wal et al. 2015). With the exception of *T. fortunei*, all IAPS were perceived as native. Without actually knowing species (and participants were lacking "taxonomic" knowledge) a distinction by "origin" is hard to make as one cannot tell whether a species is native by just looking at it. It might thus be advisable to skip the native-alien distinction in public information and education and to concentrate instead on the actual risks a species might cause (Selge et al. 2011, Boonman-Berson et al. 2014, van der Wal et al. 2015). Perceived abundance and damage to nature and the economy, rather than non-nativeness, influenced attitudes towards species management (van der Wal et al. 2015).

In general, participants were rather supportive of a removal of IAPS. However, information about negative effects does not change beauties into beasts. The present results highlight that laypersons may ignore the damage attractive IAPS can cause, and thus not support their removal in settlement areas and gardens, especially when these species do not affect human health. Information on IAPS should thus not only focus on their general impact, but rather on reasons for the eradication and control in particular locations. First attempts in this direction have already been made in Switzerland. Cantonal authorities and NGOs have published a number of information sheets about IAPS for garden owners, and flyers about, e.g., *Solidago canadensis* have

been distributed to garden owners who live close to conservation areas (for an example see DGS 2015).

The present results highlight also the importance of taxonomic knowledge. Although taxonomic knowledge of laypersons may be irrelevant for the effective management of IAPS, it is still an important proxy for people's reaction to IAPS. Six out of the eight IAPS in the present study are included in the "Swiss Ordonnance on Organism Dissemination in the Environment 814.911" and may therefore not be introduced in the environment in Switzerland. However, a lack of knowledge of these species is likely to limit the efficiency of this legal obligation. If laypersons are unable to identify these IAPS, they are also unable to detect them and report them to the authorities. One way to counteract this lack of "taxonomic" knowledge could be to directly engage the public in eradication projects. Nationwide "root-out-days" are yearly events in Switzerland where the public receives information about the IAPS in focus (in 2015 *Solidago canadensis*, http://www.arten-ohne-grenzen.ch/). Personal experience and direct involvement in the root-out-event might foster the understanding of the public of the damage caused by IASP and the necessity of measures to control even beautiful invasive plants.

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Supplementary material 1

Short description of the eight invasive alien plant species
Authors: Petra Lindemann-Matthies
Data type: species description

Supplementary material 2

English translation of the questionnaire
Authors: Petra Lindemann-Matthies
Data type: text translation