

1 **Public attitudes to the management of invasive non-native species in Scotland**

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28 **Public attitudes to the management of invasive non-native species in Scotland**

29

30 **Abstract**

31 Invasive non-native species are one of the main threats to biodiversity. Consequently there is a
32 need to control or eradicate those species that are causing problems in order to mitigate their
33 impact. Such management programmes can be controversial and in some cases have been
34 delayed or halted because of opposition from pressure groups. Public support can be critical to the
35 success of such projects, and understanding the underlying attitudes of the public can help inform
36 outreach education activities. To assess attitudes towards invasive species management and
37 investigate socio-demographic factors influencing such attitudes, a questionnaire survey of 600
38 randomly selected members of the public in Scotland was conducted, and a total of 248 completed
39 questionnaires returned. The level of support for control and eradication programmes was, in
40 general, high and was higher amongst men, older people, and people who had previously heard of
41 control and eradication projects. The species to be managed influenced levels of support, and
42 projects to control birds were the least supported. Respondents with prior knowledge of control and
43 eradication programmes and members of conservation organisations, in general, showed higher
44 levels of support, indicating the important role that awareness and education has in terms of
45 increasing public support for invasive non-native species management projects.

46

47 **Keywords:** Alien, Control, Education, Eradication, Public opinion

48 **Introduction**

49 It is widely acknowledged by conservationists that invasive non-native species are one of the
50 biggest threats to biodiversity (Diamond, 1989; Mack et al., 2000; IUCN, 2000). The Convention on
51 Biological Diversity (United Nations Environment Programme 1992) considers that eradication
52 offers the best management option for mitigating the impacts of non-native species on biodiversity if
53 prevention of their introduction fails. The Scottish Government's statutory advisory body on nature
54 conservation, Scottish National Heritage (SNH), carried out a Public Consultation exercise in 2006
55 to provide input to their policy on species management in Scotland. The consultation document
56 provided details of threatened species, native species that are the subject of control programmes,
57 and key invasive non-native species that SNH believe should be managed for the benefit of
58 Scotland's native species (SNH, 2006a). Their list included the grey squirrel (*Sciurus carolinensis*)
59 which threatens the red squirrel (*Sciurus vulgaris*) through direct competition and spread of disease
60 (Gurnell and Pepper, 1993), the New Zealand flatworm (*Artioposthia triangulata*) which preys on
61 native earthworms (Boag, 2000), and rhododendron (*Rhododendron ponticum*) which alters the
62 natural species composition of woodland by preventing native tree regeneration (Tyler et al., 2006).

63

64 The case for eradication of invasive non-natives is often strong and there is scientific support for the
65 benefits of control on biodiversity (e.g. Craik, 1998). Very few eradications, however, have taken
66 place in Europe, in comparison with other parts of the world e.g. New Zealand (Genovesi 2005).
67 Possible reasons for the low number of European eradication projects include; lack of political and
68 public awareness of the potential threats (Bertolino and Genovesi, 2003), the view that eradication
69 is an impossible goal (Bomford and O'Brien, 1995), and lack of enthusiasm amongst
70 conservationists for an activity that many people find distasteful (Temple, 1990). The eradication of
71 the coypu (*Myocastor coypus*) in the UK is one of the few successful programmes to be completed
72 in Europe (Gosling and Baker, 1989) and required extensive funding and specific legislation (Sheail,
73 2003).

74

75 Conservation managers understand that public support for their activities can be key to the success
76 or failure of the projects they undertake. This is especially true when control and eradication
77 projects are being undertaken to remove invasive non-native species. The species involved and the
78 methods of control used are likely to affect levels of public support, especially for animals or plants
79 the public find appealing (Manchester and Bullock, 2000; Fraser, 2006). In Europe this was most
80 clearly illustrated when animal rights groups initiated legal action to stop a trial eradication of grey
81 squirrels in Italy. Lethal control was halted for three years during the ensuing judicial enquiry and,
82 although the personnel involved were eventually acquitted, the rapid expansion of the squirrel
83 population during this time led to the project being abandoned (Bertolino and Genovesi, 2003).
84 Objections have also been raised over the Uist Wader Project in Scotland (SNH, 2004) and the
85 associated culling of European hedgehogs on Hebridean islands (Urquhart, 2005).

86

87 A growing number of researchers are recognising that the issue of managing invasive non-native
88 species is as much a social issue, encompassing political and human factors, as it is a scientific one
89 (e.g. Reaser, 2001). In Australia and New Zealand, where eradication programmes have become
90 well established, public surveys have been undertaken in order to help understand people's
91 reactions to proposed management and their attitudes to non-native species (Johnston and Marks,
92 1997; Fraser, 2001; Fraser, 2006). As yet very little such research has been carried out in Europe,
93 with any questionnaire-based studies usually focussed around one particular project or species.

94 These include rats on Lundy Island in North Devon (Meech, 2005), grey squirrel control (Barr et al.,
95 2002), and public attitudes to control of tree mallow on Scottish islands (Fischer and van der Wal,
96 2007). Some researchers have used contingent valuation techniques to examine conservation
97 priorities amongst the public for goose conservation (Macmillan et al., 2002), or for various
98 management programmes for wild animals in Scotland (Philip and Macmillan, 2003). With an
99 increasing recognition of the need for participatory decision making involving the public (Decker et
100 al., 1996) a better understanding of the attitudes of the general public to invasive non-native
101 species is required. In this study we aimed to assess the attitudes of the Scottish public to
102 conservation and the management of a wide range of invasive non-native species. There have

103 been a number of high profile invasive species eradication projects in Scotland in recent years (e.g.
104 Uist Wader Project, SNH, 2004; Hebridean Mink Project, SNH, 2006b), so we expected that
105 awareness may be higher here than elsewhere in the UK, allowing us to explore the influence of
106 socio-demographics on attitudes to control. Specifically we wanted to address the following
107 questions:

- 108 1. Which socio-demographic factors influence attitudes to the management of invasive non-native
109 species?
- 110 2. Do levels of support for invasive non-native species management vary between particular
111 species or taxa?
- 112 3. Do higher levels of awareness of invasive species management influence the attitudes towards
113 control or eradication programmes?

114 This information will give conservation managers a better understanding of public attitudes on which
115 they can base management decisions, education programmes and publicity.

116

117 **Materials and methods**

118

119 ***Questionnaire design***

120 Postal questionnaires consisting of ten pages (see supplementary material) asked respondents
121 about their support for invasive non-native species control, the control methods used, and level of
122 support for control of 15 non-native species. They were also asked general questions about their
123 involvement in conservation, outdoor activities, and basic demographic information. The 15 species
124 (Table 1) were selected from those listed in an SNH public consultation document (SNH, 2006a)
125 and from an audit of non-native species which suggested they had potential moderate, or highly
126 significant, impacts on either the economy or biodiversity of Scotland (Welch et al., 2001).

127

128 Table 1

129 Most questions required respondents to select their level of agreement with a particular statement
130 or with control measures for a particular species. A five-point rating scale was used with options of

131 strongly agree (= 1), agree (= 2), neither agree nor disagree (= 3), disagree (= 4) and strongly
132 disagree (= 5). At the beginning of the questionnaire there were definitions of the terms non-native
133 species, native species, invasive, control and eradication. In the final question, in which people
134 were asked about agreement with control or eradication programmes for particular species, each
135 species was illustrated with a picture and a description explaining the impacts they had on
136 biodiversity. In order that the questionnaire returns be, as far as possible, representative of the
137 opinions of the Scottish public, the sample (n=600) was proportionally stratified by the population
138 size, mid-year estimates 2005 (General Register Office for Scotland, 2006), of the 32 council areas
139 across Scotland so reflecting the actual distribution of the population (Sapsford and Jupp, 1996).
140 The council areas were then mapped onto phone book areas and the relevant number of people
141 selected from the phone book using a random numbers method. To encourage return of the
142 questionnaire, the first mailing, including a self addressed envelope, was followed by a reminder
143 letter 10 days later. To those that failed to respond to the reminder, the questionnaire was re-sent
144 after a further 20 days. The use of the phone book for postal questionnaires does have certain
145 limitations (see discussion and conclusions), but has the strong advantage of allowing stratification
146 of a named sample set, and the use of reminders as outlined above has been found to lead to high
147 return rates of around 50% (e.g Zinn and Manfredo, 1998).

148

149 Socio-demographic variables of age, education, employment, country of birth and ethnicity, were
150 categorised using the same categories as the 2001 Census (General Register Office for Scotland,
151 2001).

152

153 ***Data analysis***

154 The influences of socio-demographic variables (e.g. age, gender) on levels of agreement with
155 statements regarding attitudes to conservation and invasive non-native species were tested by
156 backward ordinal regression (using the polytomous universal model (PLUM, Norušis, 2005)). To
157 explore whether individual species or taxa influenced acceptance of control or eradication, the
158 scores from respondents for particular species (strongly agree = 1 to strongly disagree = 5) were

159 analysed using a Kruskal Wallis ANOVA (Siegel and Castellan, 1988). The 15 individual species
160 also represented six different groups; mammals, birds, plants, invertebrates, fish and crustaceans,
161 and the mean scores per respondent for each group were analysed in a similar way. For those
162 groups where control had less support, a binary response variable was created for respondents
163 agreeing (a score of 1 or 2) and neutral or disagreeing (a score of 3, 4 or 5) with control, and
164 backward logistic regression used to investigate the influence of socio-demographic variables on
165 attitudes towards control of these groups. The difference in attitude between those who had
166 previously heard of control and eradication projects for certain species, and those who had not, was
167 analysed using chi-squared tests. Statistical analyses were carried out using SPSS v 13.0 (SPSS
168 Inc., 2005) and SigmaStat v 3.11 (Systat Software Inc., 2004) with a significance level of 5%.

169

170 **Results**

171

172 ***Return rate***

173 Of the 600 questionnaires sent out, 47 were returned undelivered. This gave an effective sample
174 size of 553, of which 274 (49%) were returned. Of these 26 were only partially completed and were
175 omitted from the analyses. Analysis of the 248 fully completed questionnaires indicated that those
176 returned reflected the proportional population sizes of the council areas that were sampled. Due to
177 the way the population is distributed across Scotland respondents were therefore concentrated from
178 areas in, and surrounding, Edinburgh and Glasgow, although responses were also received from
179 councils all over Scotland including the Highlands and Islands. These Scottish council areas are
180 assigned to urban or rural categories by the Scottish Executive (Scottish Executive, 2004) based on
181 population density, and our survey returns exactly matched the overall Scotland figures (of 69%
182 urban and 31% rural).

183

184 ***Demographic statistics***

185 The socio-demographic profile of the respondents closely matched that of the total population when
186 compared with the 2001 Scottish Census (General Register Office for Scotland, 2001). There was a

187 higher proportion of male respondents (55% male, 45% female), but this was not significantly
188 different from the gender proportions in the population ($\chi^2 = 2.61$, d.f. = 1, n.s.). Respondents were,
189 however, significantly older than would have been expected from a random sample ($\chi^2 = 21.43$, d.f.
190 = 5, $P < 0.01$), and included more highly qualified people (degree level or higher; $\chi^2 = 13.06$, d.f. = 4,
191 $P < 0.05$).

192

193 ***Attitudes to conservation***

194 We asked a number of questions about awareness of, and involvement in, conservation activities to
195 explore the influence of such factors on people's attitudes. Respondents were asked if they were
196 members of wildlife, conservation or heritage organisations, and 64 (26%) respondents said they
197 were members of at least one such organisation. Of our respondents, 30 (12%) were members of
198 the National Trust for Scotland, followed by 13 (5%) who were members of the Royal Society for the
199 Protection of Birds. There were six (2%) who were members of the British Association for Shooting
200 and Conservation and one member of the Game Conservancy Trust.

201

202 Of respondents asked how they heard about issues relating to the Scottish countryside, only 11
203 (4%) people said they didn't hear about such issues. The main medium for communication was
204 television which 200 (81%) people said was one source of such information. This was closely
205 followed by newspapers, which was a source for 187 (75%) respondents. Only 34 (14%) people
206 said they got this type of information from the Internet. When asked whether protecting the Scottish
207 countryside and its wildlife should be a Government funding priority, 210 (85%) respondents agreed
208 or strongly agreed with the statement. An ordinal regression (PLUM) test of the influence of socio-
209 demographic factors and agreement with this statement found no significant variables at the 5%
210 level.

211

212 ***Attitudes to control and eradication***

213 Several questions, in the form of statements, asked people how much they agreed with control or
214 eradication programmes. The questions gave examples of different reasons for these programmes

215 being carried out, such as to protect a threatened species. A total of 216 (87%) respondents agreed
216 or strongly agreed that controlling some wildlife (native or non-native) is necessary to help conserve
217 the environment, whilst only five (2%) disagreed. The majority of respondents (73% to 84%)
218 supported control or eradication of invasive non-native species causing economic damage, or those
219 harming native, or threatened, Scottish species (Table 2). Fewer people (45%) supported the
220 eradication of all invasive non-native species to protect native species, although a further 37%
221 neither agreed or disagreed with this statement. There were several demographic variables
222 significantly associated with responses to these statements (Table 2). Men were more likely to
223 agree with general wildlife control, eradication of all invasive non-native species and those
224 specifically to conserve threatened species, and were marginally more likely to support for control
225 and eradication programmes to protect native Scottish species. Older people, particularly those in
226 the 45-54 age group, were more likely to agree that control and eradication programmes should be
227 carried out for economic reasons, and to protect native Scottish species. People in full time
228 employment were more likely to support eradication of all invasive non-native species. Respondents
229 who had previously heard of control and eradication projects were more likely to support general
230 wildlife control and control and eradication programmes to protect threatened species, although
231 membership of a conservation organisation was not shown to be significant. There were no
232 significant differences between the responses of urban and rural residents to any of the questions.

233

234 Table 2

235

236 A total of 170 (69%) people agreed that the methods used for control would affect their level of
237 support for control or eradication programmes (Fig. 1), and a backward binary logistic regression
238 indicated no significant socio-demographic variables associated with responses to this question. Of
239 10 control measures cited in the questionnaire, seven were applicable to animals and three for
240 plants. Control measures respondents disagreed with most were poisoning (49%) for animal control
241 and herbicides for plant control (25%).

242

243 Figure 1

244

245 ***Attitudes to particular species or taxa***

246 There was a significant difference in the level of agreement for control between individual species

247 (Kruskal Wallis: $H_{14} = 575.0$; $P < 0.001$). Post hoc Dunn's tests showed that respondents agreed

248 most with control and eradication programmes for Japanese knotweed and giant hogweed and

249 least with programmes for ruddy duck, Canada goose and rhododendron. There were also

250 significant differences in the mean scores given for the six taxa (KW: $H_5 = 194.6$; $P < 0.001$; Fig. 2),

251 with respondents less willing to support control and eradication projects for birds than other taxa.

252 There was a significant relationship between gender and mean score, when scores for all species

253 were averaged and then converted into a binary response of agree or disagree, with men more

254 likely to agree to control and eradication programmes for the species listed than women ($\chi^2 = 8.33$,

255 d.f. = 1, 246 $P = 0.004$),.

256

257 Figure 2

258

259 Because support for control programmes involving birds was significantly less than other taxonomic

260 groups, possible explanatory variables were investigated for respondents agreeing or disagreeing

261 with bird control. Respondents who were members of conservation organisations were more likely

262 to support control programmes for birds ($\chi^2 = 6.09$, d.f. = 1, 246, $P = 0.014$). Questions about

263 attitudes to particular control methods and attitudes to species control were asked separately,

264 however, certain species can only be successfully removed using a method some people find

265 objectionable. In the case of the brown rat, which is usually controlled or eradicated through the use

266 of poison, 113 (50%) of the 226 people who supported rat eradication disagreed with the use of

267 poisoning as a control method. When examining the results for the ruddy duck, where control can

268 involve shooting, only 19 (17%) of the 109 people that supported eradication disagreed with the use

269 of shooting as a method of control.

270

271 A total of 80 respondents (32%) had previously heard of programmes to control the numbers of
272 invasive non-native species in Scotland. Of these the majority, 68 (85%), cited those involving
273 mammals. For those respondents (n = 48) who had heard of the programme to eradicate European
274 hedgehogs from islands in the Scottish Hebrides there was a significant association between prior
275 knowledge and increased level of support ($\chi^2 = 10.36$, d.f. = 1, $P = 0.001$; Fig. 3). Of those who had
276 heard of programmes to control or eradicate grey squirrels (n = 36) and American mink (n = 12)
277 there was also a significant association between prior knowledge of programmes and increased
278 level of support (grey squirrels: $\chi^2 = 5.32$, d.f. = 1, $P = 0.021$; American mink $\chi^2 = 4.72$, d.f. = 1, $P =$
279 0.030, using Yates' Correction; Fig. 3).

280

281 Figure 3

282

283 **Discussion and conclusions**

284

285 This study attempted to provide a wider view of public opinion on the management of invasive non-
286 native species than has been attempted previously in the UK. It enabled us to examine the role of
287 particular species, the methods used, and the socio-demographic background and prior knowledge
288 of the respondents, in shaping attitudes towards control and eradication programmes. All
289 questionnaire-based studies have certain limitations in relation to how representative of the general
290 public they are (Sapsford, 1999). We used a stratified random sampling procedure to minimise
291 sampling bias but recognise that, because not all members of the public are in the phone book, and
292 those that are tend to be the head of the household, often older males, some bias may still exist. In
293 addition, there is the possibility of non-response bias. There does appear to be some degree of
294 non-response bias in the respondents of this survey; younger people and those with fewer formal
295 qualifications were less likely to respond, a common finding in surveys of this nature (Sapsford,
296 1999; White et al., 2003). Self selection amongst respondents would also mean those people with a
297 strong interest in the topic are more likely to respond. In terms of assessing the attitudes of the
298 public in relation to invasive species management, however, those who are strongly in favour and

299 those strongly against control may be equally likely to respond. That respondents were older than
300 would have been expected from a random sample likely indicates some degree of sampling bias
301 and possibly also a response bias. In addition, the number of respondents belonging to
302 conservation organisations (n=64, 26%) was very high in this survey and it is possible that those
303 who were members of conservation organisations were more likely to respond to this questionnaire.
304 Data on the proportion of the public who are members of conservation organisations is not easily
305 available, however statistics from 1998 indicated there were 228,000 members of the National Trust
306 for Scotland and over one million RSPB members in the UK (Office for National Statistics, 2000). A
307 2002 survey of public attitudes to the environment in Scotland (Scottish Executive, 2005) involving
308 4,000 people found that only 5% of the respondents reported membership of a “green” organisation,
309 although 23% said they had made a one-off payment to an environmental group in the past 12
310 months. These figures, however, are not directly comparable because respondents were left to
311 decide which organisations were ‘green’ and membership of specific organisations was not reported.
312 Although we are unable to account for non-response bias, we feel these data can be used to
313 assess the views of the general public in Scotland due to the broad similarities between the socio-
314 demographic profiles of respondents and the public and the high return rate achieved (45%).

315

316 Respondents to the questionnaire showed high levels of support for control and eradication
317 programmes, a result similar to some of those found in a previous survey of members of the public
318 in the Aberdeen area of Scotland as part of a contingent valuation study (Philip and Macmillan,
319 2005). In their survey they found that 75% of respondents approved of management programmes
320 involving humane culling to protect rare species whilst our study found 84% of respondents
321 favoured control for this reason. In contrast, whereas only 38% of respondents in the initial
322 questionnaire by Philip and Macmillan (2005) favoured eradication of invasive non-native species to
323 protect native species, a much higher proportion of respondents in our survey (78%) agreed that
324 control and eradication of non-native species should be conducted for this reason.

325

326 ***Socio-demographic factors influencing attitudes***

327 Studies on conservation management and the values, beliefs and attitudes of the public have
328 focussed on gender differences (Dougherty et al., 2003), and how an understanding of values can
329 help wildlife resource managers develop a constructive dialogue on conservation issues with the
330 public and stakeholders (Miller, 2003; Fischer and van der Wal, 2007). Studies on control options
331 for deer management have indicated that men are more likely to accept lethal control, whilst women
332 prefer contraception as a method regardless of its effectiveness at controlling deer (Lauber et al.,
333 2001). Other studies have not found any differences between the attitudes of men and women in
334 terms of management options (Zinn and Pierce, 2002). It may be that the reasons given for using
335 lethal control, such as whether control is for reasons of human safety or protection of livestock,
336 equally influence people's preferences. Our survey indicated that gender may have an impact on
337 attitude; men were more likely to agree that all invasive non-native species should be eradicated,
338 and should be controlled to aid conservation objectives and specifically to protect rare species. Men
339 were also significantly more likely to agree to control and eradication for the 15 species listed in the
340 questionnaire. For these reasons care should be taken to account for gender bias in sampling.
341 Other factors influencing attitudes to control and eradication in the survey were the age of
342 respondents, and whether they had previously heard of any projects to control or eradicate species
343 in Scotland. Those in the age group 45-54 were more likely to support control and eradication for
344 economic reasons, or to protect native species, but it is not clear if these are attitudes related to age
345 *per-se* or those of a particular generation. In the USA there have been suggestions of differences
346 between urban and rural residents in terms of attitudes towards animal rights, animal welfare and
347 trapping (Kellert, 1996). There was no evidence of such differences between urban and rural
348 residents in this survey. A similarity in attitudes between urban and rural residents, as found in this
349 survey, has also been demonstrated in Australian and New Zealand surveys on public attitudes to
350 vertebrate pest management and introduced wildlife control (Johnston and Marks, 1997; Fraser,
351 2001), and in a survey of public attitudes to brown bears in Slovenia (Kaczensky et al., 2004).

352

353 ***Attitudes to different control methods***

354 Poisoning and other chemical control, such as herbicides, were the least supported methods; a
355 similar finding to other studies (Barr et al., 2002; Sheail, 2003; Fraser, 2006). Many respondents
356 commented that they abhorred the thought of taking any creature's life but where it was absolutely
357 necessary it should be done as humanely as possible. There was a discrepancy between the
358 control methods people had objections to and those species they agreed with controlling. This was
359 particularly true in the case of the brown rat and the use of poison; of the respondents supporting
360 rat eradication (91%), half said they would not support the use of poisons. Further research to
361 investigate how the level of information available to people influences their attitudes to these issues
362 would be of value to conservation managers and public authorities. In particular it would be useful
363 to explore whether understanding the range of control options and their efficacy, along with the
364 impacts in terms of levels of animal suffering, affects attitudes.

365

366 ***Species and taxonomic bias effects***

367 Researchers have previously demonstrated taxonomic bias in conservation research and in
368 reintroduction projects (Seddon et al., 2005), with a focus on mammals and to a lesser extent birds.
369 A review of successful eradication projects in Europe (Genovesi, 2005) found none involving
370 invertebrate, plant or marine organisms, although this could be because those groups are harder to
371 eradicate successfully. Fraser (2001) found the public were less happy with control projects for
372 larger non-native species, which tended to involve mammals. In this survey many more
373 respondents had heard about mammal control and eradication programmes, possibly due to the
374 amount of publicity these particular projects have had in recent years. However, even where there
375 had been a great deal of publicity, as in the case of European hedgehog eradication on Hebridean
376 islands, knowledge of the project in our survey was still generally low (19%). Where respondents
377 were asked to agree with control or eradication programmes for specific species there was
378 significantly less support for projects involving birds or rhododendron, and a tendency to strongly
379 agree with those projects that involved the Japanese knotweed or giant hogweed. In general
380 taxonomic terms, bird control projects were the least supported, although even here the median
381 response score (= 2.6, equidistant between "agree" and "neither agree nor disagree") was in favour

382 of control. Veitch and Clout (2001) have suggested that the public may view invasive species
383 differently and proposed that 'hated invasives', such as rats, were universally disliked and therefore
384 more likely to be subject to control, whilst 'attractive invasives' such as rhododendron, were less
385 likely to be controlled because they were liked for aesthetic reasons. These underlying attitudes
386 combine with the 'situational specifics' (Zinn and Manfreda, 1998), in terms of why and how the
387 species should be controlled or eradicated, to influence levels of public support.

388

389 ***Education and awareness***

390 How can the results of this questionnaire help conservation managers? Firstly it helps highlight the
391 importance of understanding the values and attitudes held by the general public with respect to
392 wildlife control. There is a general willingness amongst the respondents of this survey to support
393 conservation management but they need help to understand the threats that non-native species can
394 pose. Where respondents knew about control projects their level of support for control of particular
395 species increased. This supports the view that explaining activities and the reasons behind wildlife
396 control operations will help increase public support (Mack et al., 2000; Fraser, 2006). In a
397 contingent valuation study (Philip and Macmillan, 2005), for example, the researchers found that
398 support for control and eradication projects for non-native species increased from c. 38% to 78%
399 following focus group meetings to discuss particular projects. The role the media can play in the
400 dissemination of information can be problematic, in part because of the tendency to sensationalise
401 news items (Goulding and Roper, 2002). This can create the impression that opposition from animal
402 rights groups, for example, represents the public view to a greater extent than may be the case,
403 whilst also clouding the conservation justification for control and eradication with arguments about
404 the control methods and potential animal suffering.

405

406 Conservation managers and policy makers should find the high levels of support for management
407 programmes amongst the general public found here reassuring. However, results from this
408 questionnaire suggest that knowledge of invasive species, and programmes to control their impacts,
409 remains low in Scotland. In addition, there appears to be a wide gulf between preferred methods of

410 control and those that are of most practical use for particular species. This study indicates that
411 awareness of particular projects is associated with increased levels of support. It is therefore
412 important that those involved in invasive species management continue to engage directly in public
413 outreach activities that don't shy away from the 'nasty necessity' of eradicating non-native species
414 (Temple, 1990). Instead they should explain why such management projects are essential to
415 conserve the habitats and native species the public know and love. Numerous studies have argued
416 for the greater involvement of local communities at the earliest stages of detection of non-native
417 impacts and use of the public during the decision making process (Barr et al., 2002; Philip and
418 Macmillan, 2005). Where the reasons for eradication have been fully explained to the public there
419 tends to be greater public support, as has been the case with the eradication of American mink in
420 the Western Isles of Scotland. Eradication projects that have been initiated by people at the local
421 level, such as the coypu eradication in the UK, had full local support and success was achieved
422 with little negative public response (Sheail, 2003). Until people have more personal experience and
423 understanding of the damage caused by non-native species they will not realise the benefits of
424 control and eradication programmes (Fraser, 2006).
425

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427

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Table 1

Species	Type
Green spruce aphid (<i>Elatobium abietinum</i>)	Terrestrial invertebrate
New Zealand flatworm (<i>Artioposthia triangulata</i>)	Terrestrial invertebrate
Rhododendron (<i>Rhododendron ponticum</i>)	Terrestrial plant
Giant hogweed (<i>Heracleum mantegazzianum</i>)	Terrestrial plant
Grey squirrel (<i>Sciurus carolinensis</i>)	Mammal
Ruffe (<i>Gymnocephalus cernua</i>)	Fish
Signal crayfish (<i>Pacifastacus leniusculus</i>)	Crustacean
Brown Rat (<i>Rattus norvegicus</i>)*	Mammal
American mink (<i>Mustela vison</i>)	Mammal
European hedgehog (<i>Erinaceus europaeus</i>)*	Mammal
Chinese mitten crab (<i>Eriocheir sinensis</i>)	Crustacean
Ruddy duck (<i>Oxyura jamaicensis</i>)	Bird
Canada goose (<i>Branta canadensis</i>)	Bird
Japanese knotweed (<i>Fallopia japonica</i>)	Terrestrial plant
Zebra mussel (<i>Dreissena polymorpha</i>)	Aquatic invertebrate

* only on islands

Table 2

Significant at the 5% level	Coefficient	S.E.	Wald	d.f.	Sig. (P)
<i>Controlling some wildlife (both native and non-native) is necessary to help conserve the environment (87% agreed, 2% disagreed, 11% neither agreed or disagreed)</i>					
Prior knowledge of projects	-0.803	0.273	8.631	1	0.003
Gender	-0.576	0.258	4.994	1	0.025
<i>All invasive non-native species living in Scotland should be eradicated (totally removed), where possible, to protect native species (45% agreed, 18% disagreed, 37% neither agreed or disagreed)</i>					
Employment	-0.139	0.43	10.328	1	0.001
Gender	-0.619	0.237	6.806	1	0.009
<i>Non-native species should be controlled or eradicated where they cause economic damage (74% agreed, 17% disagreed, 9% neither agreed or disagreed)</i>					
Age	-0.221	0.078	8.012	1	0.005
<i>Non-native species should be controlled or eradicated where they do damage to any native Scottish species (78% agreed, 10% disagreed, 12% neither agreed or disagreed)</i>					
Age	-0.228	0.078	8.608	1	0.003
Gender	-0.467	0.244	3.657	1	0.056
<i>Non-native species should be controlled or eradicated where they do damage to threatened Scottish species (84% agreed, 2% disagreed, 14% neither agreed or disagreed)</i>					
Gender	-0.651	0.246	7.031	1	0.008
Prior knowledge of projects	-0.593	0.261	5.147	1	0.023

Figure 1

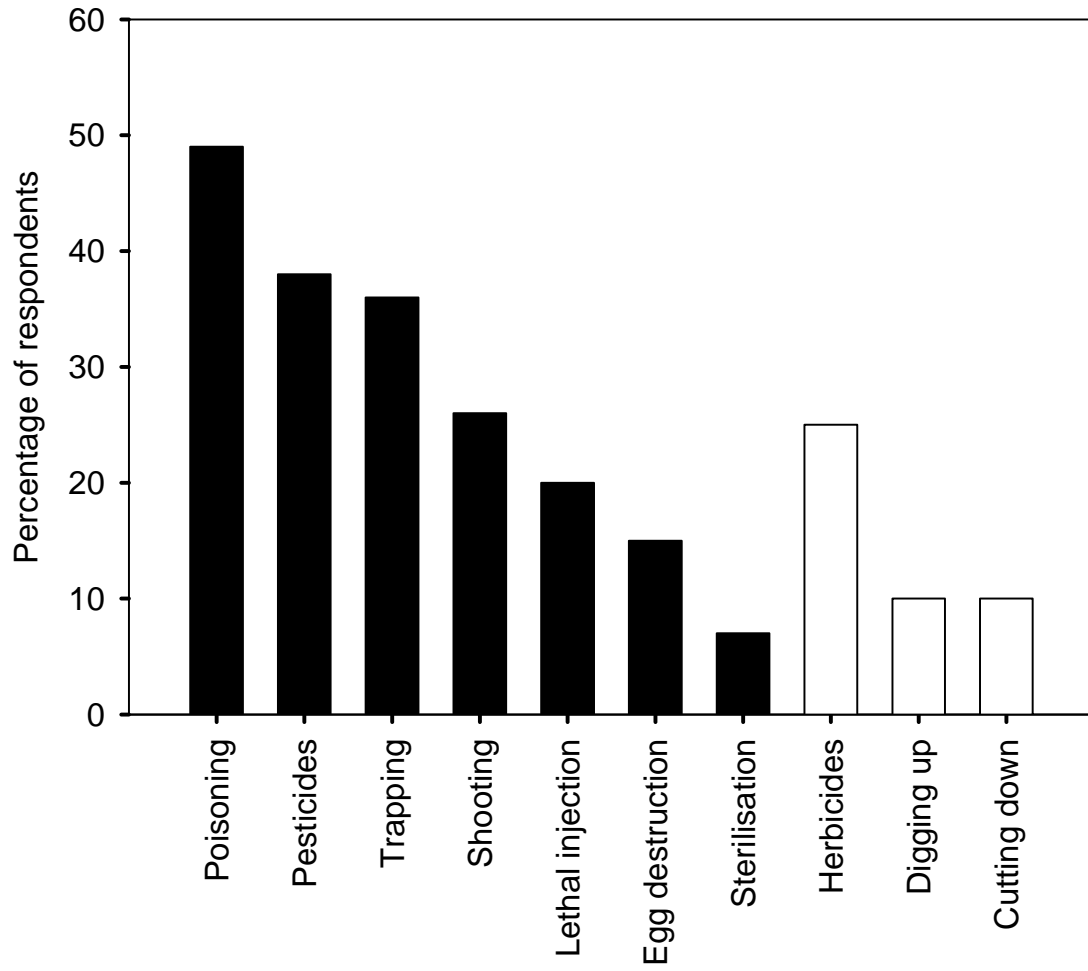


Figure 2

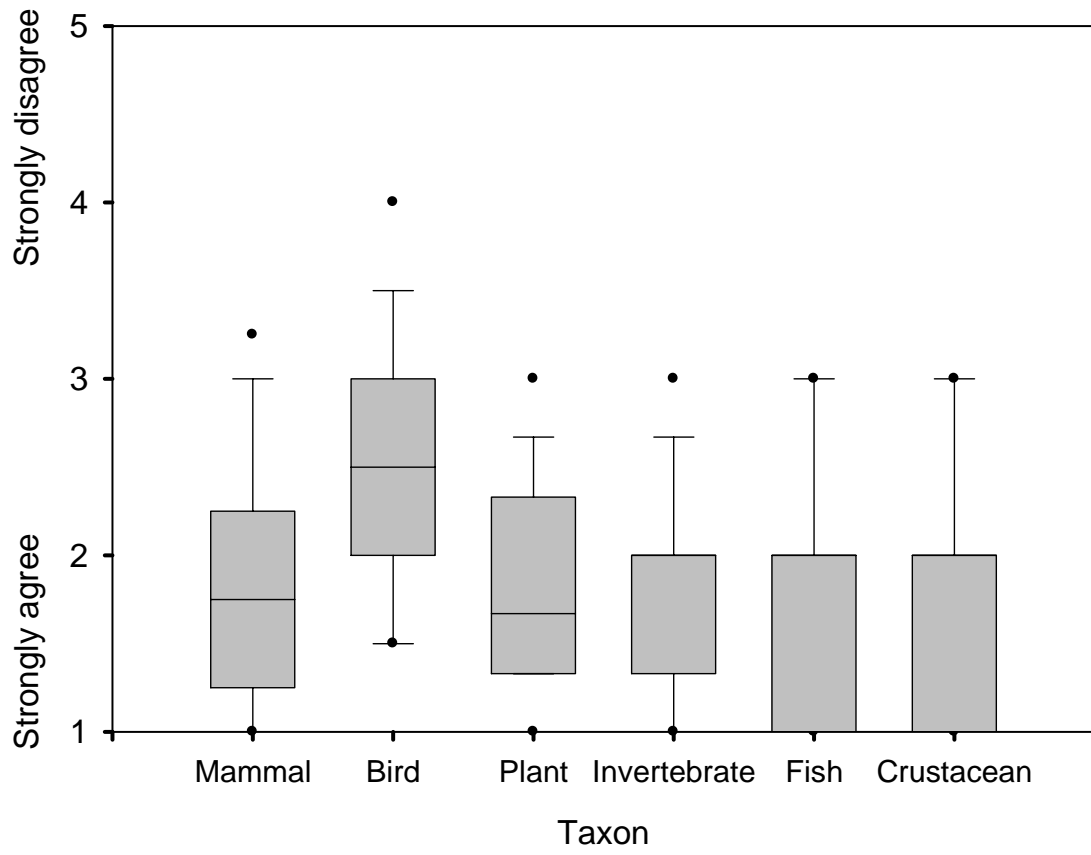


Figure 3

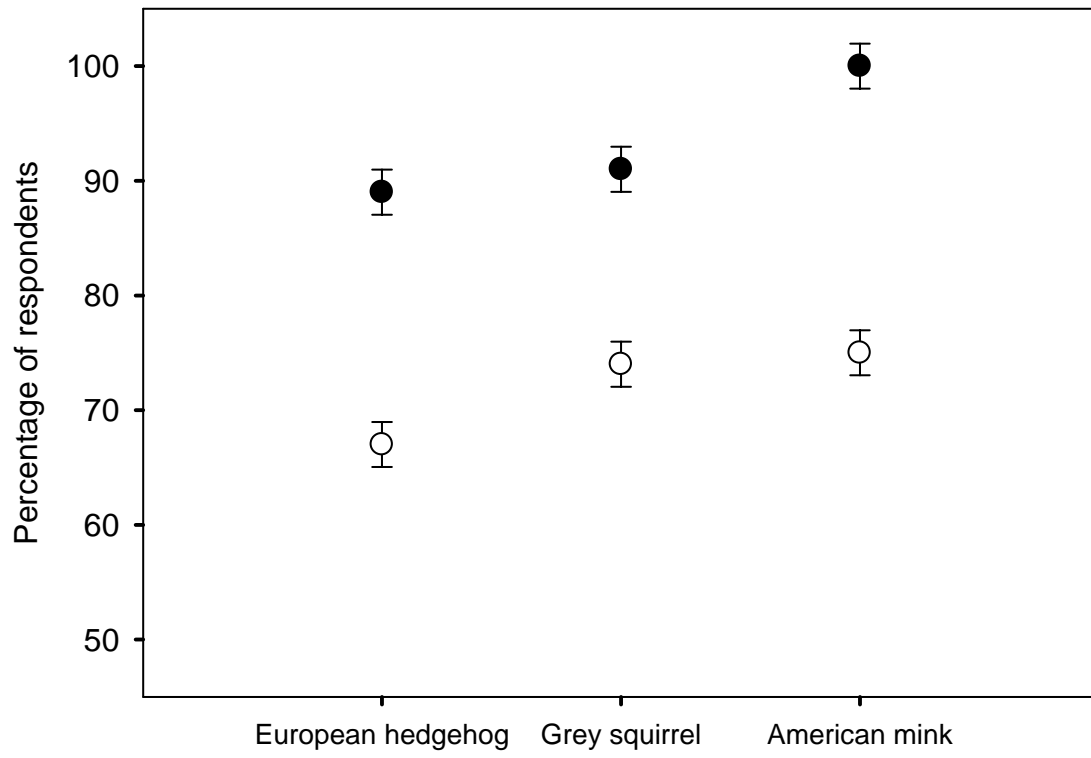


Table and figure legends

Table 1

The common and Latin names, and type of organism, of the 15 invasive non-native species referred to in the questionnaire.

Table 2

Coefficients and *P* values associated with significant socio-demographic variables derived from backwards ordinal regression (PLUM) tests of attitudes to particular statements on conservation and non-native species management.

Figure 1

The percentage of respondents in the survey disagreeing with the use of particular animal and plant control methods for conservation management.

Figure 2

Comparison of respondents' scores for control or eradication of different taxa. Lower scores indicate a higher level of agreement. Box plots shown here indicate 10th, 25th, 50th, 75th and 90th percentiles with horizontal lines and all data points outside this range.

Figure 3

The proportion of respondents agreeing with control and eradication of three species of invasive non-native mammals in the UK according to whether they had previously heard of control and eradication projects for these species (filled circles) or not (open circles). Control of European hedgehog specifically relates to where this species has been introduced outside its native range in the Scottish Hebrides. Errors are 95% confidence intervals.

Supplementary information

CONSERVATION AND NON-NATIVE SPECIES IN SCOTLAND

This survey asks for your opinions on conservation and in particular how you feel about the control of invasive non-native species in Scotland, some of which have been the subject of debate in the past.

Non-native species are those species that have been introduced by human activities to an area outside their natural range. In the case of some animals (e.g. hedgehogs) they may be native to Scotland but have been introduced to some islands by humans. Many non-native species do not cause any damage but others go on to be invasive (see definition below) and can be a threat to native species, especially those that are already rare or endangered.

Native species are those occurring naturally in an area, in this case Scotland.

Invasive means the species causes harm, for example through eating native species, competing with them for food, or by introducing diseases.

Control usually involves the use of lethal methods to remove a species or reduce its numbers. It could take the form of humane killing (e.g. lethal injection), shooting, trapping, poisoning, digging up or application of herbicides (in the case of plants).

Eradication means the total removal of a species from an area.

INSTRUCTIONS

Please use a ball point pen to complete the questionnaire. Put an 'X' in the appropriate box. For example:

If you make a mistake and cross the wrong box, please block out your answer and then cross the correct box.

For example:

ABOUT YOU

1. What is your gender?

Male Female

2. What is your age?

18-34 35-44 45-54

55-64 65-74 75+

3. What is your country of birth?

- England Scotland Northern Ireland
- Republic of Ireland Wales
- Elsewhere (please specify) _____

4. What is your ethnic group?

- White Asian Black Chinese
- Mixed or other ethnic group (please specify) _____

5. Which of these qualifications do you have?

- 'O' grade, Standard Grade, Intermediate 1, Intermediate 2, GCSE, CSE, Senior Certificate *or equivalent*
- Higher grade, CSYS, Scottish Group Award at Higher, 'A' Level, AS Level, Advanced Senior certificate *or equivalent*
- GSVQ/SVQ Level 1 or 2, SCOTVEC/National Certificate Module, BTEC First Diploma, City and Guilds Craft, RSA Diploma *or equivalent*
- GSVQ/SVQ Level 3, ONC, OND, SCOTVEC National Diploma, City and Guilds Advanced Craft, RSA Advanced Diploma *or equivalent*
- HNC, HND, SVQ Level 4 or 5, RSA Higher Diploma *or equivalent*
- First degree (e.g. BA, BSc)
- Higher degree (e.g. MA, MSc, PhD, PGCE, post-graduate certificates/diplomas)
- Professional Qualifications (for example, teaching, accountancy)
- Other qualifications (please specify) _____
- No qualifications

6. What is your employment status?

- | | |
|--|---|
| <input type="checkbox"/> Working full time | <input type="checkbox"/> Working part time |
| <input type="checkbox"/> Student | <input type="checkbox"/> Permanently sick or disabled |
| <input type="checkbox"/> Unemployed | <input type="checkbox"/> Looking after home or family |
| <input type="checkbox"/> Retired | |

7. If you currently work, or have previously worked, what is/was the full title of your main job?

8. Do any aspects of your job involve countryside management?

- Yes No

YOUR ATTITUDES TOWARDS CONSERVATION AND NON-NATIVE SPECIES IN SCOTLAND

9. Are you a member of any wildlife, conservation or national heritage organisations?

- Yes (please select from list below) No
- | | |
|--|--|
| <input type="checkbox"/> National Trust for Scotland | <input type="checkbox"/> Heritage Scotland |
| <input type="checkbox"/> Game Conservancy Trust | <input type="checkbox"/> Royal Botanic Gardens |
| <input type="checkbox"/> Woodland Trust | <input type="checkbox"/> Scottish Wildlife Trust |
| <input type="checkbox"/> World Wildlife Fund | <input type="checkbox"/> Friends of the Earth |
| <input type="checkbox"/> Greenpeace | <input type="checkbox"/> Royal Society for the Protection of Birds |
| <input type="checkbox"/> British Association for Shooting and Conservation | |
| <input type="checkbox"/> Other (please specify) _____ | |

10. Where do you hear about the issues facing the Scottish countryside or its wildlife?

- Television Newspapers Internet
- Radio Magazines or journals
- I don't hear about such issues
- Other (please specify) _____

11. Have you taken part in any outdoor activities in the past year?

- Skiing Walking Climbing Shooting
- Fishing Bird-watching Cycling Sightseeing
- Other (please specify) _____

12. Protecting the Scottish countryside and its wildlife should be a Government funding priority

- Strongly agree Agree Neither Agree or disagree Disagree Strongly disagree

13. Controlling some wildlife (both native and non-native) is necessary to help conserve the environment

- Strongly agree Agree Neither Agree or disagree Disagree Strongly disagree

14. All invasive non-native species living in Scotland should be eradicated (totally removed), where possible, to protect native species

- Strongly agree Agree Neither Agree or disagree Disagree Strongly disagree

15. Non-native species should be controlled or eradicated where they cause economic damage

- Strongly agree Agree Neither Agree or disagree Disagree Strongly disagree

16. Non-native species should be controlled or eradicated where they do damage to any native Scottish species

- Strongly agree Agree Neither Agree or disagree Disagree Strongly disagree

17. Non-native species should be controlled or eradicated where they do damage to threatened Scottish species

Strongly agree Agree Neither Agree or disagree Disagree Strongly disagree

18. Have you heard of any projects to control the numbers of any invasive non-native species in Scotland?

Yes No

If yes, please give details

19. The most effective control strategies differ between species, where they are living and how many of them there are. Would the chosen methods of control have an influence on your decision to support such projects?

Yes No

If yes which of the following would you NOT support?

Animals

- Shooting
- Poisoning
- Lethal injection
- Trapping
- Pesticides
- Sterilisation or use of contraceptives
- Egg destruction

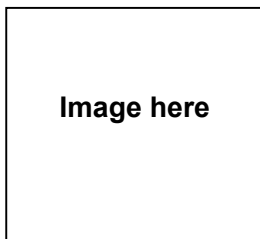
Plants

- Cutting down
- Digging up
- Herbicides

20. The following is a list of 15 non-native species that are living in Scotland. Most have been found by scientific research to be a potentially significant threat to the Scottish economy or native species and have been suggested as subjects for control programmes.

Control for each one would depend on which method successfully removed the species but would usually involve lethal methods in the form of humane killing (e.g. lethal injection), shooting, trapping, poisoning, digging up or application of herbicides (in the case of plants).

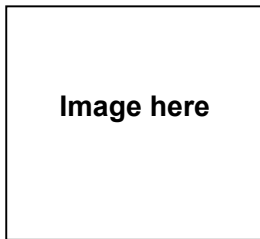
After each one you are asked how you feel about this species being controlled.



a) Brown rat (on islands)

Introduced accidentally to small islands, the brown rat eats the eggs and young of many seabirds. It has led to huge declines in the breeding populations of rare birds like the Manx shearwater, and has also affected razorbills and guillemots.

Strongly agree Agree Neither Agree or disagree Disagree Strongly disagree



b) Ruddy duck

Introduced to the UK as an ornamental waterfowl in the 1940's, this bird has spread to Spain where it threatens the European white tailed duck by mating with it and producing hybrids.

Strongly agree Agree Neither Agree or disagree Disagree Strongly disagree



c) Japanese knotweed

Introduced as a garden plant in the 19th century this plant is extremely invasive and colonises most habitats even growing through walls, concrete and tarmac. It grows very densely and shades out other plants suppressing growth of native plants and damaging buildings.

Strongly agree Agree Neither Agree or disagree Disagree Strongly disagree



d) New Zealand flatworm

A flat pink and black worm that lives in damp soils this was introduced to Scotland accidentally in the 1960s. It eats native earthworms and can therefore have a detrimental impact on the natural health of soils.

- Strongly agree Agree Neither Agree or disagree Disagree Strongly disagree



e) Ruffe

Introduced to Loch Lomond accidentally through its use as live bait in fishing, this fish grows very fast and competes with other fish species as well as feeding on the eggs of the native powan (a fish) which is a protected species.

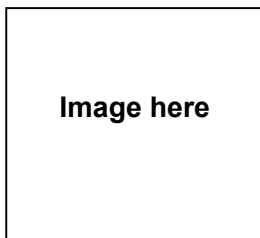
- Strongly agree Agree Neither Agree or disagree Disagree Strongly disagree



f) Chinese mitten crab

This crustacean has been accidentally introduced to the UK through ships ballast water and causes damage to riverbanks by burrowing into them which may be a threat to flood defences and other bank constructions. They also threaten native crayfish species through competition, eat salmon eggs and are a nuisance for commercial fisheries.

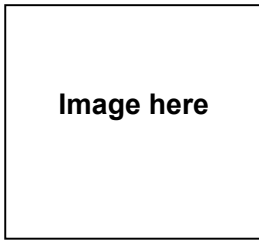
- Strongly agree Agree Neither Agree or disagree Disagree Strongly disagree



g) Hedgehog (on islands)

Hedgehogs were introduced to the Uists in 1974 and grew to a population of several thousand. They eat the eggs of wading birds, some of which are rare, and have led to large decreases in the populations of some species.

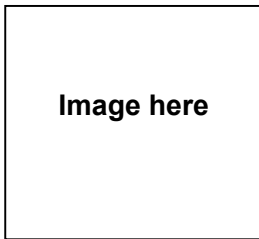
- Strongly agree Agree Neither Agree or disagree Disagree Strongly disagree



h) Rhododendron

Introduced to the UK in the 18th century as an ornamental garden plant, Rhododendron then spread into nearby woodland and the wider countryside. The dense shade it casts reduces the growth of native woodland plants and can prevent native tree regeneration. This has led to a reduction in both native woodland plants and the insects that live on them.

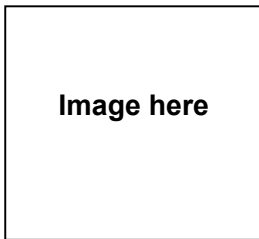
- Strongly agree Agree Neither Agree or disagree Disagree Strongly disagree



i) Canada goose

Introduced as a game species there are now over 50,000 pairs of this bird in the UK. It congregates in large numbers where its droppings can raise nutrient levels in lakes. It competes with livestock for available grass and also feeds on crops causing damage.

- Strongly agree Agree Neither Agree or disagree Disagree Strongly disagree



j) American mink

Introduced to the UK for the fur trade mink have now established in the wild and eat ground-nesting birds and water voles. Mink also have a significant impact on fish farming, river fisheries and poultry farms.

- Strongly agree Agree Neither Agree or disagree Disagree Strongly disagree



k) Zebra mussel

Introduced accidentally in the 19th century the mussel can reach high densities which foul up water bank equipment such as water treatment works. The animal also alters the food web in waterways leading to the disappearance of some native water wildlife.

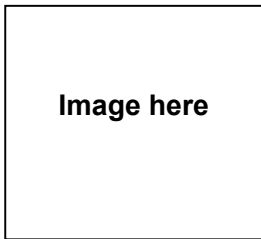
- Strongly agree Agree Neither Agree or disagree Disagree Strongly disagree



l) Giant hogweed

This introduced species looks very similar to the native hogweed and cow parsley but is much larger. It has large leaves which shade the ground and block the growth of native plants. It dies back in winter leaving bare ground causing erosion near rivers. The sap of the plant reacts in sunlight leading to blistering of the skin.

- Strongly agree Agree Neither Agree or disagree Disagree Strongly disagree



m) North American signal crayfish

Introduced to the UK for fish farming escaped animals cause damage to river banks and fish spawning beds and are voracious predators. They are a threat to the native white-clawed crayfish and many species of fish.

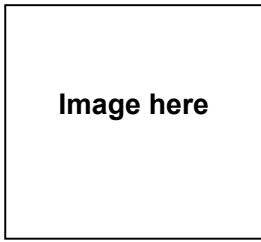
- Strongly agree Agree Neither Agree or disagree Disagree Strongly disagree



n) Grey squirrel

Introduced to the UK in the late 19th century the grey squirrel has replaced the native red squirrel by dominating food sources. Grey squirrels also spread a disease which does not affect their health but kills red squirrels.

- Strongly agree Agree Neither Agree or disagree Disagree Strongly disagree



o) Green spruce aphid

A non-native species of aphid this lives on the sap of pine species and large outbreaks cause serious damage to Sitka spruce plantations by killing off the needles.

Strongly agree Agree Neither Agree or disagree Disagree Strongly disagree

Finally, do you have any other comments you'd like to make about the subject of this survey?