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Evaluating conservation volunteers perceptions towards Japanese knotweed (*Reynoutria japonica*) in the City of Swansea – and how they may shape future management strategies.

by

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Author's Declaration:

I declare that the work in this dissertation was carried out in accordance with the regulations of the University of Wales, Trinity Saint David. The work is original except where indicated by special references in the text and no part of the dissertation has been submitted for any other degree.

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STATEMENT 1

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ABSTRACT:

Invasive Alien Plant Species (IAPS) are an important global issue, negatively effecting natural environments and human societies. The IAP Japanese knotweed (*Reynoutria japonica*) is a particularly fast growing, herbaceous and perennial plant that has a negative reputation as being difficult to manage and eradicate. Knotweed is particularly prominent in the City of Swansea which has been described as ‘the knotweed capital of the world’. The purpose of this research was to establish conservation volunteers perceptions towards knotweed within the City of Swansea to inform future knotweed management strategies.

The research identified conservation volunteers perceptions towards knotweed within the City of Swansea; applied Shackleton *et al.*, (2019) conceptual framework of influential factors on perception of Invasive Non-Native Species (INNS) to evaluate the identified perceptions and made strategic, tactical and operational recommendations for future knotweed management strategies.

The research used an exploratory case study approach. A systematic literature review was undertaken and an online questionnaire developed to identify perceptions in conservation volunteers. Semi-structured interviews were undertaken to test whether volunteers had different perceptions to knotweed specialists.

There was found to be a predominantly negative perception of knotweed amongst conservation volunteers in Swansea City which agreed with findings in the literature review. Correlations using Fischer’s exact test identified five new insights into volunteers perceptions that were not present in the published literature.

The new insights contribute to more effective management of knotweed and to the broader discussion of perceptions within the scientific community. The identified perceptions only apply to the geographical area of Swansea City and are a proxy for other areas of Wales and beyond. Recommendations were constructed into a model for future knotweed management making strategic, tactical and operational recommendations.

Key Words: Japanese Knotweed, Perceptions, Invasive Non-Native Species, Invasive Alien Plant Species, Conservation Volunteers

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GLOSSARY:

Biological invasions: *“The process by which species with no historical record in an area breach biogeographic barrier and extend their range”* (McGraw - Hill, 2003:12)

Ecosystem disservices: *“Defined as the functions processes and attributes generated by the ecosystem that result in perceived or actual negative impacts on human wellbeing”* (Shackleton et al., 2016:590)

Ecosystem services: *“The benefits people obtain from ecosystems”* (Millennium Ecosystem Assessment, 2005: V)

Invasive Alien Plants: *“Naturalised plants that produce re-productive offspring, often in very large numbers, at considerable distance from parent plants”* (Richardson et al., 2000:93)

Invasive Alien Species: *“Animals and plants that are introduced accidentally or deliberately into a natural environment where they are not normally found, with serious negative consequences for their new environment”* (IUCN.org)

Invasive Non-Native Species: *“Any non-native animal or plant that has the ability to spread causing damage to the environment, the economy, our health and the way we live* (Non-Native Species Secretariat, 2019)

Perceptions: *“A systematic interpretation of sensory information or an environment by the brain”* (Schacter, 2011:15)

Urban ecology: *“Urban ecology is the scientific study of the relation of living organisms with each other and their surroundings in the context with the urban environment”* (Nimela, 1999:119)

ABBREVIATIONS:

IAPS: Invasive Alien Plants:

IAS: Invasive Alien Species:

INNS: Invasive Non-Native Species

LNR: Local Nature Reserve

CHAPTER 1: INTRODUCTION

1.1: What was the purpose of the research?

Invasive Alien Plant Species (IAPS) are an important global issue, negatively effecting natural environments and human societies.

The adverse effects are well documented in the literature with examples of how they damage the ecological environments they occupy (Brooks *et al.*, 2004; Hansen and Clevenger, 2005; Dutta, 2018), how they damage human societies (McNealy *et al.*, 2001; Pejchar and Mooney, 2009; Santo, 2017) and their detrimental effects on economies at global and local levels (Charles & Dukes, 2008; CABI, 2010; Wentworth, 2013). In the UK alone the total annual costs were estimated to be £1.7 billion pounds in 2010 (CABI, 2010).

As part of understanding the effects of IAPS it is important to understand people's perception of the issue in order manage their concerns and behaviours towards that issue (Shackleton *et al.*, 2019).

Provisional reading of the literature suggested that in many parts of the world IAPS are mostly misunderstood and management strategies are often based on suspicion and fear (Gobster, 2005). Understanding perceptions is also increasingly important in achieving conservation and management objectives such as preserving biodiversity and managing habitats (Robinson, 2016; Potgieter *et al.*, 2018).

The purpose of this research was to identify individual's perceptions towards the effects of an identified IAP in this case Japanese knotweed (*Reynoutria japonica*), hereby known as knotweed. Conservation volunteers were selected for the research because of their keen interest in the environment and conservation (Ryan *et al.*, 2001). This meant that they were more likely to have an established perception of the environmental effects of IAPS as opposed to members of the general public.

The research selected conservation volunteers who volunteered within the boundaries of the City of Swansea.

Swansea City was chosen as the geographical area of interest due to the documented high density of knotweed. From a 1998 survey of the area of the City and County of Swansea it was estimated that knotweed covered up to 0.25% of the 400km₂ area surveyed (Child et al., 2001) and has been referred to as the 'knotweed capital of the world' (Shaw, 2010).

Knotweed is a fast growing, herbaceous and perennial plant (Fennell *et al.*, 2018). It originates on volcanic slopes in Eastern Asia (Bailey & Connelly, 2000) and its impacts are known to:

- Reduce biodiversity in plants and animals (Manchester & Bullock, 2000; Gerber *et al.*, 2008)
- Damage infrastructure (Fennell *et al.*, 2018)
- Increase flood risk (CABI, 2010)
- De-value properties (Santo, 2017)
- Impact on human health and wellbeing (The Property Voice.com, 2014; Vaz *et al.*, 2017)

All knotweed plants in the UK are from a single female clone and are sterile (Hathaway, 2000). The plant reproduces asexually and is spread through a rhizome network via soil and water channels which makes it extremely difficult to manage (Beerling, 1994; Hathaway, 2000).

Knotweed was originally introduced in the early 19th century by the Victorians and was perceived as an attractive ornamental garden plant (Bailey & Connelly, 2000). It was listed on the United Kingdom (UK) Government website as one of the five most commonly found IAPS in the UK (Gov.uk, 2014).

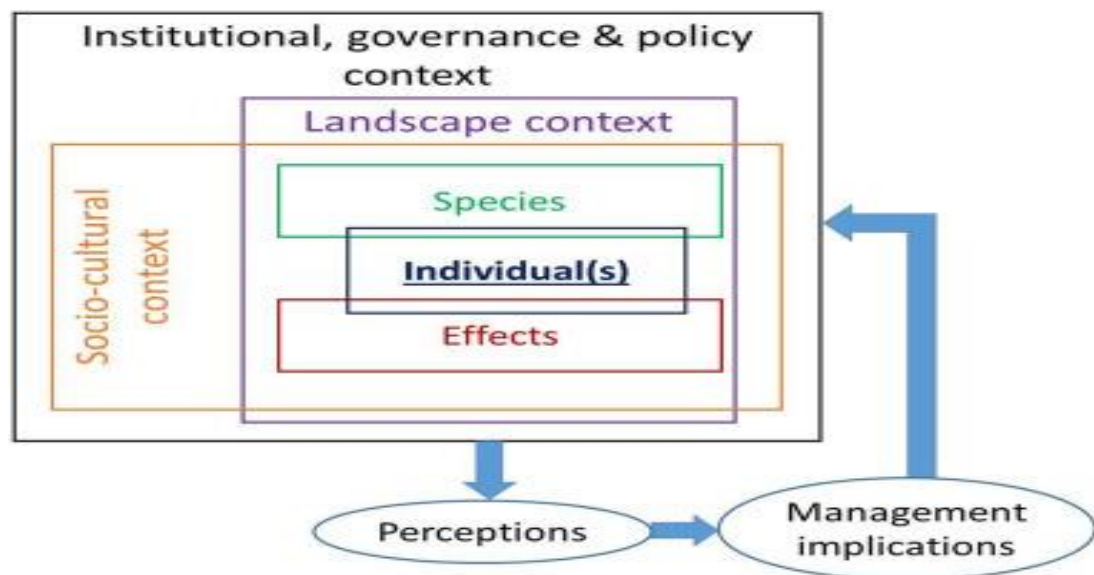
Due to the far-ranging damaging effects of knotweed, legislation has been passed under the UK Wildlife and Countryside Act of 1981 making it 'illegal to cause knotweed to grow in the wild' (Wildlife and Countryside Act, 1981, Section 114 (2)). The plant is also considered a 'controlled waste' and its legal disposal has to be licenced (Djeddour & Shaw, 2010).

1.2: Why was the topic chosen?

A provisional scoping search using the University of Wales Trinity Saint David (UWTSD) library catalogue and Google Scholar on 1st of May 2019 identified that knotweed research had traditionally focused on the ecological and biological effects of invasions on the landscape rather than the effects on humans (Garcia-Llorente *et al.*, 2008). Very little had been published on understanding perceptions of knotweed (McNeely, 2001) with no published literature on conservation volunteer's perceptions of knotweed within the City of Swansea.

The author had observed a broad range of perceptions towards knotweed within the City of Swansea. The anecdotal observation suggested that most perceptions were negative towards knotweed.

In 2019 an influential paper was published explaining people's perceptions of Invasive Non-Native Species (INNS) which included IAPS such as knotweed. The authors identified a conceptual framework that explained perceptions of INNS (Shackleton *et al.*, 2019). The authors identified a framework of six interlinked primary factors that influenced perceptions of INNS (*Figure 1*).



Source: Shackleton *et al.*, 2019:12

Figure 1: The primary factors influencing perceptions of INNS.

The authors also published a list of sub factors that influenced the primary factors (Figure 2):

Table 1: Underlying factors behind the primary factors outlined in Figure 1. Note that these factors interact with each other, and are dynamic across space and time.

Primary factors in Figure 1	Underlying factors
<i>Individual(s)</i>	Demographic characteristics Experience of species and effects Knowledge systems Sense of place Social relationships and group membership Value systems
<i>Species</i>	Introduction status Residence time Species traits Taxonomic/functional group
<i>Effects (Potential and realised)</i>	Economic Ecological Social
<i>Socio-cultural contexts</i>	Land tenure system Management history Public and media discourse Socio-economic development Social institutions Social memory Social value systems
<i>Landscape context</i>	Availability of alternative resources (e.g., from native species) Ecosystem type Land use and cover Landscape beauty/scenery or attractiveness Management history Native community structure
<i>Institutional, governance and policy context</i>	Historical processes Institutional frameworks International agreements Legislation, regulation and enforcement Policy and governance strategy

Source: Shackleton *et al.*, 2019:12

Figure 2: The sub-factors behind the primary factors.

The key findings of the paper were:

- Perceptions of INNS in urban landscapes differed considerably from rural landscapes with INNS considered more problematical in the latter
- Perceptions of INNS differed according to ‘attractiveness’ and ‘usefulness’
- Shifts in perceptions occurred as INNS become more prevalent in wild landscapes

1.3: Aim and objectives of the research

Aim:

The aim of the research was to establish conservation volunteer's perceptions towards knotweed within the City of Swansea in order to inform future knotweed management strategies.

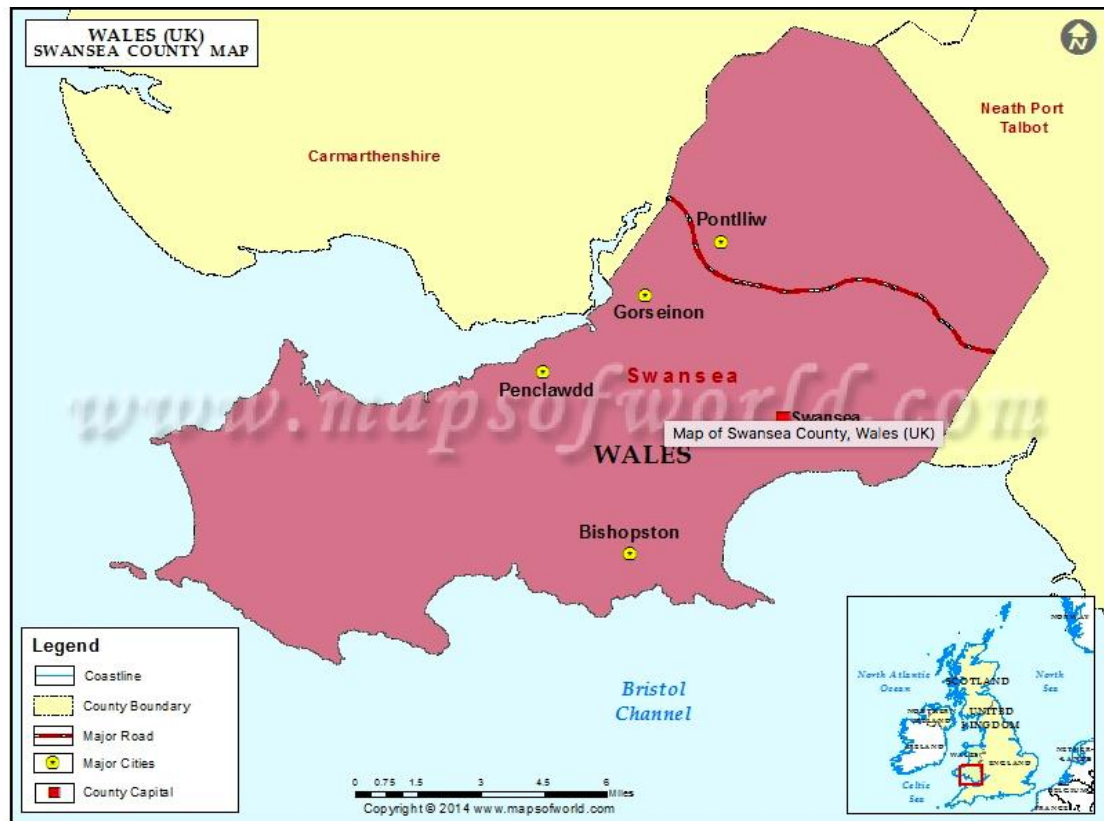
Objectives:

1. To establish conservation volunteer's perceptions of knotweed in Swansea City as a case study
2. To apply Shackleton *et al.*, (2019) conceptual framework to the established volunteer's perceptions and to evaluate the underlying sub-factors that shape those perceptions
3. To make strategic, tactical and operational recommendations for knotweed authorities to use in future management strategies

1.4: What was the scope of the research?

Since the industrial revolution Swansea City had transformed from one of the world's largest copper manufacturers into a post-industrial seaside town with large areas of industrial wasteland in its urban centre. That process had facilitated the spread of knotweed throughout urban areas (Beerling, 1991; Hathaway 2000). The first recording of knotweed in the UK was on a landfill site 23km east of Swansea in 1890 (Van Ham *et al.*, 2013). Records of complaints from residents of Swansea about the presence of knotweed date from the 1970's.

In Swansea knotweed was known to be present in most man-made and natural habitats and effects and is present in most land types (Hathaway, 2000). Knotweed is documented to have caused many problems to biodiversity, cultural services, economic activity and to human health and wellbeing within Swansea City (Van Ham *et al.*, 2013). For all of the reasons above the scope of the research was limited to the boundaries of Swansea City.



Source: Map of Swansea County, Wales (UK), 2014

Figure 3: A map of the City and County of Swansea.

1.5: What were the limitations of the research?

The research only examined conservation volunteers perceptions and did not establish perceptions amongst the general public.

The identified perceptions only apply to the case study of Swansea City and can be used as a proxy for other areas of Wales and beyond.

The identified perceptions are a 'snapshot' at a single point in time and not a longitudinal study.

1.6: The structure of the research

The research was structured in six chapters with references and appendices and used a Harvard system of referencing.

CHAPTER 2: LITERATURE REVIEW

2.1: Introduction

The aim of the literature review was to address two components of the research question:

- Search A: Perceptions of knotweed
- Search B: Management of knotweed

A systematic literature review was undertaken in June 2019 on global published literature, grey literature, websites and other sources published in English within the last 50 years. The abstracts were scrutinised and scored using the CRAAP test (Currency, Relevance, Accuracy, Authority and Purpose) and non-relevant papers discarded (Blakeslee, 2004). In total 105 relevant sources were identified. The full articles and reports were obtained and reviewed for their validity and relevance using the CRAAP test.

The library catalogue was used to gather key papers using three search terms:

- Perceptions of knotweed
- Management of knotweed
- Knotweed in urban areas

Other sources of identified literature included:

- UK and Welsh Government publications and websites
- Local government publications and websites
- National and local newspaper publications and websites

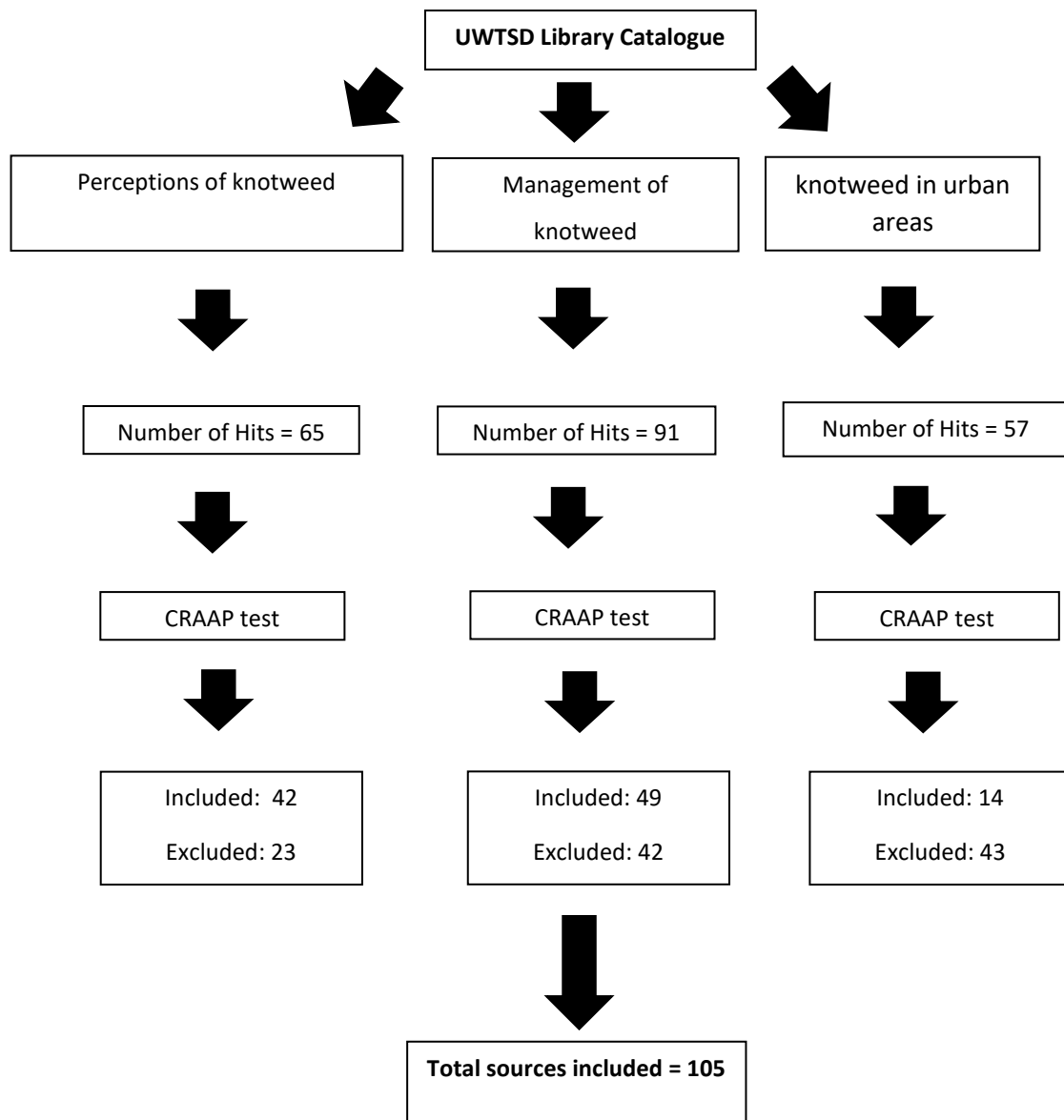


Figure 4: Literature search flow diagram.

2.1.1: Literature review identified themes

A total of 213 papers and other sources were identified. One hundred and eight sources were discarded as not relevant and 105 sources were used to identify key themes and sub themes listed below:

Search A: Perceptions

- Theme A1: Perceptions of knotweed and ecological services
- Theme A2: Perceptions of the effect of globalisation on IAPS
- Theme A3: Perceptions of knotweed in the urban environment
- Theme A4: Perceptions of risks from knotweed
- Theme A5: Perceptions of knotweed in the media

Search B: Management

- Theme B1: Public and professional management preferences for knotweed
- Theme B2: Governmental advice for managing knotweed
- Theme B3: Strategic management of knotweed within Swansea

Search A: Perceptions

2.2 Theme A1: Perceptions of knotweed and ecological services

Of the 105 sources collected during the literature review, 17 sources were found to be relevant to theme A1.

There was a debate within the literature on whether individual IAPS provided ecological services or disservices (Charles & Dukes, 2008; Shackleton et al., 2011; Vilà et al., 2011). An ecological service was defined as *“the benefits people obtain from ecosystems”* (Millennium Ecosystem Assessment, 2005:V). An ecological disservice was defined as *“the functions, processes and attributes generated by the ecosystem that result in perceived or actual negative impacts on human wellbeing”* (Shackleton et al., 2016:590).

Some publications argued that certain IAPS can benefit human society. For example the prickly pear provided people in the Makana Municipality in South Africa with numerous commercial and non-market services; and the various uses of Australian Acacias (*Acacia s.l*) across the world (Kull et al., 2011; Shackleton et al., 2011).

There was an extensive body of published literature on the disservices of IAPS such as increasing the spread of wildfires (Brooks et al., 2004), decreasing the pollinator

population (Munoz & Cavieres, 2008) and decreasing human wellbeing (Pejchar & Mooney, 2009).

2.2.1: Ecological services from knotweed

There were a limited number of publications that supported knotweed as an ecological service provider. However, a report by a knotweed specialist Environet found that the plant was used in a variety of sweet and savoury recipes and contained minerals and vitamins for human consumption. It also reported that knotweed had been used for medicinal purposes such as rashes in its native habitat for centuries (Environet.com, n.d.).

2.2.2: Ecological disservices from knotweed

Many publications discussed how knotweed caused damage to man-made infrastructure (The Property Voice, 2014; Ellery, 2016; Fennell *et al.*, 2018). Knotweed had been credited to *“grow up to 20cm a day” “exploits gaps in tarmac and concrete”* and *“devalue property by thousands of pounds”* (The Property Voice, 2014:1). Fennell *et al.*, (2018) in association with the University of Leeds measured knotweed’s capacity to cause structural damage against three common damage mechanisms:

- Direct damage from physical impact
- Direct damage from physical pressures
- Indirect damage

Surprisingly the authors concluded that:

“No support was found to suggest that *R. Japonica* causes significant damage to built structures, even when it is growing in close proximity to them and certainly no more damage than other plant species that are not subject to such stringent lending policies” (Fennell *et al.*, 2018:1).

The paper had a limited sample size and was not applicable to new built properties and older housing (House of Commons, 2009).

Other identified disservices includes knotweed’s capacity to reduce biodiversity in the area that it inhabits through outcompeting and dominating other flora and fauna

(Maurel *et al.*, 2009). Maurel *et al.*, found that knotweed undermined soil structure and quality by reducing the cover of other plants.

Vaz *et al.*, (2017) found that perceptions of IAPS's benefits and its nuances were dependent on social attitudes and management practices. The authors also stated that nuances were reduced by appropriate actions such as educating the public on the ecological services and disservices of knotweed.

2.3 Theme A2: Perceptions of the effect of globalisation on IAPS

Of 105 sources collected during the literature review, 12 sources were found to be relevant to theme A2.

The process of globalization had helped facilitate the spread of knotweed internationally and had also homogenised views on the species across borders (Robinson, 2016).

There was consensus within the literature that globalized processes encouraged the spread of IAPS through new trade routes, markets and products (Hulme, 2009; Meyerson & Mooney, 2009). Hulme argued that technical and logistical developments since the 1950's had enabled IAPS to rapidly spread across borders.

In 2000 J.P Bailey and A.P Connelly from the University of Leicester published a paper on the history of knotweed in the UK. The numerously cited paper found that in the case of knotweed it has been argued that rapid spread in the United Kingdom began as early as the 19th century facilitated by colonialism (Bailey & Connelly, 2000).

One positive outcome from an increasingly globalized world was the sharing of IAPS location data across borders (Crall *et al.*, 2010). The authors also stated that all IAPS data could be centralised into an electronic database for authorities and citizens scientists to share effective management strategies.

Another positive development from globalization was the development of international IAP laws and policies (Shine, 2007). Establishing an international law framework would facilitate a global perception to IAPS. Shackleton *et al.*, (2019) paper also outlined factors influencing perceptions of INNS in the institutional, governance and policy context. Shine (2007) also argued that a coherent strategic

policy on IAPS at all levels of government would improve the public's perceptions of INNS such as knotweed especially if environmental and economic impacts were minimised.

There was much debate within the literature over what constitutes an 'invasive plant' (Richardson *et al.*, 2000; Starfinger *et al.*, 2003; Rotherham 2005; Trudgill, 2008; Shackleton *et al.*, 2011; Van Der Wal *et al.*, 2015; Lindermann-Matthies, 2016). Some argued for changes to invasion terminology to be less negative (Richardson *et al.*, 2000; Colautti & Richardson, 2008). Whilst others stated that certain invasive plants were perceived to be a beautiful or an important part of the perceived landscape (Trudgill, 2008; Kull *et al.*, 2011; Lindermann-Matthies, 2016). As human induced biological invasions increase through globalized processes there was a need to re-consider what was perceived as invasive and non-native (Starfinger *et al.*, 2003).

2.4 Theme A3: Perceptions of knotweed in the urban environment

Of 105 sources collected during the literature review, 26 sources were found to be relevant to theme A3.

The United Nations predicted that by 2050, 68% of the world's population will live in cities, currently 55% of the world's population live in cities (United Nations, 2018). Francis and Chadwick state:

“Urban ecosystems may now represent the contemporary and future human environment. Consisting of green space and the built environment, they harbour a wide range of species, yet are not well understood” (Francis & Chadwick, 2013:2).

In the literature IAPS were perceived to cause numerous negative impacts to cities both to the ecological integrity and to biodiversity of resident flora and fauna (Maurel *et al.*, 2009; Chmura *et al.*, 2013; Potgieter *et al.*, 2019). IAPS were also perceived to impact on many aspects of human society in cities such as de-valuing property and impacting on transport networks (Stokes, 2001; Payne & Hoxley, 2012; Santo, 2017; Fennell *et al.*, 2018; Peat *et al.*, n.d.).

Some publications suggested that the city should be considered a human and biological ecosystem in its own right (Savard *et al.*, 2000; Francis *et al.*, 2011).

Biological invasions from IAPS will represent an increasing threat to all biodiversity within the city ecosystem in contemporary and future contexts (Francis & Chadwick, 2013).

Despite the knowledge on environmental and social impacts caused by IAPS, there was a lack of published literature on how IAPS were perceived in the urban environment. Notable publications included single city case studies such as in Cape Town, South Africa (Potgieter *et al.*, 2019), and a Swiss multiple city study (Lindermann-Matthies, 2016). Despite a gap in the literature there were several concepts that influenced human perceptions of knotweed within urban environments. These concepts were:

- Aesthetic
- Property value
- Legislation
- Land use

Aesthetic: A study by Lindemann-Matthies (2016) found a correlation that the more ‘beautiful’ an IAPS species was perceived to be, the less likely laypersons were to report the IAP to management authorities. Historically knotweed was considered aesthetically pleasing with the plant winning prizes for aesthetic beauty at Kew Gardens 1882 and in Utrecht in 1847 (Bailey & Connelly 2000). In contrast modern perceptions were likely to be more ‘beastly’ and were influenced by negative portrayals in the media (The Property Voice, 2014; BBC News, 2018; Ledbury Reporter, 2019) and this is discussed in Theme A5.

Property value: In 2019 the online newspaper The London Economic published a survey that found 32% of British citizens would purchase a property that had knotweed on the premises (Peat *et al.*, n.d.). It was estimated that up to 5% of all UK properties were affected by knotweed either directly or indirectly (Environet.com, n.d.). A study by Santo (2017) found that property devaluation occurred due to stigma that blinded the general public from the real risks posed by knotweed.

Legislation: The Wildlife and Countryside Act of 1981 prohibited landowners to allow knotweed to spread into the wild (Gov.uk, 2016). The high legal cost of enforcement and treatment created a culture of fear amongst property owners (Payne & Hoxley, 2012; Santo, 2017). However, this this was not always the case. Payne and Hoxley (2012) found that:

“knotweed spreading from neighbouring properties was a potential problem, but in practice, neighbours usually reached mutual agreement to avoid high legal costs” (Payne & Hoxley, 2012:24).

Land use: IAPS were documented to spread along urban transport corridors such as rivers, railways and road networks (Hansen & Clevenger, 2005; Cottet *et al.*, 2015; Ledbury Reporter, 2019). In the literature there was consensus that integrated and cohesive urban planning was vital in stopping the spread of IAPS in cities (Niemela, 1999; Potgieter *et al.*, 2018, 2019). Shackleton *et al.*, (2019) identified the landscape context as one of the six factors influencing perceptions of INNS and emphasised the link between effective land use and perceptions (Shackleton *et al.*, 2019).

2.5 Theme A4: Perceptions of risks from knotweed

Of 105 sources collected during the literature review, 29 sources were found to be relevant to theme A4.

Risk perception was defined as:

“The subjective assessment of the probability of a specified type of accident happening and how concerned we are with the consequences” (Sjoberg *et al.*, 2004:8).

Psychologist Paul Slovic PH.D. suggested that health and safety regulators must consider how the public think about and respond to a known risk (Slovic, 1987). It was important for knotweed authorities to consider how the public thinks about and responds to perceived risks from knotweed.

When the principles of risk perceptions were applied to IAPS it was difficult to estimate the level of threat posed (Rotherham, 2005). In the case of knotweed not all the perceived risks associated with the plant caused an imminent danger to humans (Robinson *et al.*, 2017).

This theme examined how risk perceptions of IAPS effected human livelihoods and health and wellbeing. It also examined human risk perceptions to native plants, animals and perceived 'native' landscape.

2.5.1: Risk perceptions from IAPS to human livelihoods and health and wellbeing

The perceived risk from IAPS on human livelihoods was a matter for debate depending on the characteristics of the IAP and the human and biological environment it inhabited. Shackleton et al., (2019) had undertaken a literature review into the role of IAPS in shaping local livelihoods and wellbeing. The authors found certain IAPS to be beneficial to wellbeing and other papers indicated that IAPS have *"major detrimental effects which increase community's vulnerability within social and ecological systems"* (Shackleton et al., 2019:154). The authors concluded that IAPS effects on wellbeing were not fixed but change due to complex social and ecological processes.

Kull *et al.*, (2011) examined the differences in perceptions of Australian Acacias (*Acacia s.l*) in 15 countries. The authors found that perceptions were shaped by economic conditions where poorer countries heavily relied on Acacia's economic opportunities, middle income countries tended to invest in commercialising woodlots and richer countries tended to focus on eradication.

There were examples of IAPS benefiting human livelihoods such as in the work of Shackleton *et al.*, (2011) who found that certain IAPS such as the prickly pear provided economic benefits to farmers in the Makana province in South Africa. Conversely in the UK the costs of IAPS to the economy were estimated at £1.7 billion (CABI, 2010).

Human health and wellbeing and perceptions of IAPS was a topic considered in its academic infancy (Shackleton et al., 2019). Shackleton *et al.*, (2011) found that certain IAPS such as the prickly pear can benefit human welfare by generating an income for farmers in South Africa and was also used for food and medicine. Other studies examined the wellbeing impact that IAPS had on mental wellbeing. Pimental *et al.*, (2005) found that knotweed effected homeowners morale through property devaluation and high costs of eradication. Other studies examined how IAPS

increased certain community's vulnerability to climate change thus negatively impacting on their wellbeing (Palmer, 2004).

2.5.2: Risk perceptions from IAPS to native plants and animals

Published studies suggested that IAPS caused considerable damage to the ecological environment that they occupied. Such impacts included damaging biological diversity and ecosystem function and eroding riverbanks capacities to resist flooding (Sala et al., 2000; Dutta, 2018).

The known risks from knotweed included:

- Limited growth of native plants by overcrowding (Sołtysiak & Brej, 2014)
- Reduction in animal and plant diversity (Chmura *et al.*, 2013)
- Reduction in individual species diversity by chemical release (CABI.org, 2019)
- Reduction in soil nutrients and quality (Maurel *et al.*, 2009)

Despite these known risks there was a lack of knowledge on risk perceptions within the general public and of the real risks of knotweed (Robinson, 2016).

2.5.3: Risk perceptions from IAPS to the native landscape

Some publications examined the perception of a 'native' landscape and argued that species composition had always changed due to complex climatic, human and biological factors (Trudgill, 2008).

Perceptions of IAPS were documented to change over time (Starfinger *et al.*, 2003). For example, a study on Black Cherry (*Prunus serotina*) which was an INNS in Europe, found that perceptions had changed over the several centuries from a useful tree for timber extraction to an invasive pest and eventually a tree that was considered part of the natural landscape (Starfinger *et al.*, 2003). Using the example of Black Cherry in Europe it was argued that perceptions of knotweed as part of the native landscape changed over time.

2.6: Theme A5: Perceptions of knotweed in the media

Of 105 sources collected during the literature review, 7 sources were found to be relevant to theme A5.

The media influenced the public's perception of IAPS (Santo, 2017). The identified media articles on IAPS tended to be misinformed and used various journalist techniques which overemphasised the impacts on human society (The Property Voice, 2014; Santo, 2017; Wales Online, 2018; Peat *et al*, n.d.).

The identified articles tended to use attention grabbing headlines in order to attract the reader's attention. Examples included 'The terrorist weed' (The Property Voice, 2014), 'Pest weed spotted' (Ledbury Reporter, 2019) and 'Tarmac smashing thug invading our gardens' (Yemm, 2015).

There was disproportionate reporting of the harmful effects of knotweed in the media. For example over half of the sources identified related to the theme of property devaluation from knotweed (The Property Voice, 2014; Humphries, 2018; Wales Online, 2018; Peat *et al*, n.d.). By only reporting the negative economic effects of knotweed, there was increased anxiety amongst the public (Santo, 2017).

The identified media publications reported legal disputes involving knotweed such as in the case of Williams and Another V Network Rail Infrastructure LTD (Humphries, 2018). In this legal case, two neighbours claimed the encroachment of the IAP had led to property damage and devaluation. The plaintiffs claim was accepted by the County Court on the grounds that the property's amenity and leisure value had been affected by encroachment. On appeal the plaintiffs claim was upheld but there was a discrepancy on what constitutes a 'private nuisance' (Humphries, 2018). Media articles such as this raised public anxiety over potential expensive legal disputes.

There was inaccurate media reporting on a study by Swansea University that found that 'Japanese Knotweed cannot be eradicated' (BBC, 2018). The misleading facts presented in the article appeared to be scientifically based but had the potential to increase public anxiety over IAPS management within Swansea City. The report by

Swansea University found that chemical treatment over a prolonged period weakened the IAP but the results were not guaranteed (Jones *et al.*, 2018).

Search B: Management

2.7 Theme B1: Public and professional management preferences for knotweed

Of 105 sources collected during the literature review, 54 sources were found to be directly relevant to theme B1.

Some publications focused on public perceptions of managing IAPS (Garcia-Llorente *et al.*, 2008; Sharp *et al.*, 2011; Potgieter *et al.*, 2019). One reported high levels of support amongst the general public for eradication or control (Bremner & Park, 2008). Other studies found that IAPS were considered beautiful and perceived as part of the natural landscape (Lindermann-Mattis, 2016). These differing viewpoints led to conflict on how to manage IAPS. Some papers suggested that it was good practice to consult the public prior to any management activity on IAPS (Fischer *et al.*, 2014; Van der Wal, 2015).

2.7.1: Management mechanisms

There were several published control mechanisms to manage knotweed. These included:

- Biological control (Shaw *et al.*, 2009; Djeddour & Shaw, 2010; Kurose *et al.*, 2012)
- Chemical control (Child & Wade, 2000; Jones *et al.*, 2018)
- Mechanical control (Child & Wade, 2000; Gov.Wales, 2015)

2.7.2: Monitoring mechanisms

To monitor the effectiveness of management and spread in urban areas, a Geographical Information System (GIS) or other monitoring techniques such as Object-Based Analysis were used (Jones *et al.*, 2011). Another method of monitoring using a mathematical simulation model calculated the spread of rhizome networks (Smith *et al.*, 2007).

2.7.3: Management preferences and perception

A widely cited paper by Fischer et al., (2014) found that IAPS control authorities wanted the public to be educated to accept the scientist's views on the best management practices (Fischer et al., 2014). The authors stated that *"Professionals tended to have more extreme views than the public, especially in relation to nativeness and abundance of a species"* (Fischer et al., 2014:1). The paper cited that the differing perceptions of the public and professionals could be aligned with better communication strategies.

Positive public perceptions of IAPS in cities were influenced by effective management by competent authorities (Gaetner et al., 2017; Potgieter et al., 2019). Managing IAPS in urban cities was frustrated by complicated economic, ecological and social processes (Potgieter et al., 2018). Gaetner et al., (2017) had promoted the use of a decision-support framework for managers in Cape Town, South Africa. As the decision support framework was more effective, it was shown to improve the publics' perceptions of management.

2.8: Theme B2: Government advice for managing knotweed

Of 105 sources collected during the literature review, 9 sources were found to be relevant to theme B2 which identified UK, Welsh and local government advice on knotweed.

2.8.1: UK Government advice

The UK Government listed the five most commonly found IAPS on its website (Gov.uk, 2014). The government had published guidelines for managing IAPS and advocated a range of strategies and treatments such as chemical, biological and mechanical removal (Gov. UK, 2014, 2016; Defra, 2016). The legal responsibilities of landowners with knotweed on their land is also clarified in an open access document from the Department for Environment Food and Rural Affairs (Defra, 2016).

Within the UK there was a strategic policy to engage society to manage IAS through the INNS Framework Strategy for Great Britain (Pagès et al., 2019).

2.8.2: Welsh Government advice

The estimated economic costs from IAPS to UK society is £1.7 billion with Wales accounting for £125 million (CABI, 2010). The Welsh Government with its bodies such as Natural Resources Wales (NRW) offered advice on control mechanisms for knotweed (Gov.Wales, 2015, 2018; NRW, 2019). The Welsh Government also offered advice to community volunteer groups (Gov.Wales, 2018) on various chemical, biological and mechanical methods of control.

In June 2014 the Welsh Government published a written statement on the progress of trials to control knotweed using a Psyllid called *Aphalara Itadori* as a biological control agent (Gov.Wales, 2014). Two hundred insects and fungi were identified in the trials by the Centre for Agriculture and Bioscience International (CABI) and *Aphalara Itadori* was recommended as the best option for the sustainable management of knotweed over the long term.

2.8.3: Local Government advice

Swansea City Council on its website described problems created by Knotweed locally:

- Loss of native plant species
- Physical damage to infrastructure
- Rapid uncontrollable growth
- Reduction in land and property values
- Difficulties in obtaining mortgages (Swansea.gov, 2019)

Swansea City Council offered treatment for Knotweed on all properties in addition to a Q and A section created by the Councils' Conservation Team. Swansea City Council had published a leaflet on how the general public could identify knotweed (Swansea.gov.uk, n.d.).

2.9: Theme B3: Strategic management of knotweed within Swansea

Of 105 sources collected during the literature review 32 sources were found to be relevant to theme B3:

2.9.1: Strategic management policy

The literature search identified that the Nature Conservation Team from the Planning Department of Swansea Council were responsible for managing knotweed within the City and County of Swansea (Hathaway, 2000). Prior to 1992 the management of knotweed within the city was sporadic with no long-term strategic plan for minimising the spread (Hathaway, 2000; Wade et al., 2003). The literature identified a series of actions carried out by Swansea City Council in response to complaints from the general public:

- (1992): Formation of a Knotweed work group
- (1992): First urban survey
- (1993): Urban survey information seminar
- (1997): Knotweed action plan developed
- (1998) Second urban survey
- (1998) Appointment of permanent knotweed officer

The council authorities formed a knotweed work group in 1992 which comprised of a collaboration between local authorities and external stakeholders that included British Rail, The Countryside Council for Wales, The National Rivers Authority and the International Centre of Landscape Ecology (ICOLE) (Child et al., 2001). The group shared information on best practice and resources in order to control knotweed within the authority area (Hathaway, 2000).

ICOLE published two surveys on the extent of knotweed coverage in Swansea. The first was conducted in May 1992 on a selected area of 96km² within the City and County of Swansea. The 1998 survey was conducted on the entire authority area of 400km² (Hathaway 2000; Wade et al., 2003). Both surveys showed that knotweed was predominantly concentrated within urban areas of Swansea (Hathaway, 2000).

In 1997 the City and County of Swansea published a knotweed action plan that had four aims:

- To promote and encourage a co-ordinated response to the knotweed problem
- To identify priority sites for treatment
- To prevent spread into unaffected areas
- To raise awareness and provide advice and information (Cited in Hathaway, 2000:6)

2.10: Table 1: A summary of key themes from the literature.

Search A: Perceptions	Key Themes	Search B: Management	Key themes
A1: Perceptions of knotweed and ecological services	Ecological services from IAPS commercial and non-market uses of prickly pear in SA (Shackleton <i>et al.</i>, 2011) Ecological disservices from IAPS Wildfires (Brooks et al., 2004) Pollinator impact (Munoz & Cavieres, 2008) Human wellbeing (Pejchar & Mooney, 2009) Ecological services from knotweed Cooking Medicine Ecological disservices from knotweed Damage to man-made infrastructure Reduces biodiversity Undermines soil quality	B1: Public and professional management preferences for knotweed	Management mechanisms Biological control Chemical control Mechanical control Monitoring mechanisms GIS Object- Based – Analysis Management preferences and perceptions Advising the public on best management practices (Fischer <i>et al.</i>, 2014) A management decision support framework (Gaetner <i>et al.</i>, 2017)
A2: Perceptions of the effect of globalisation on IAPS	Globalization and spread of IAPS History of knotweed in the UK Globalization and IAPS location data Globalization and international IAPS law What is an ‘invasive’ plant? IAPS terminology Beautiful IAPS?	B2: Government advice for managing knotweed	UK Government advice The five most common IAPS (gov.uk, 2014) DEFRA advice for managers of knotweed (DEFRA, 2016) Welsh Government advice Cost of IAPS in Wales (CABI, 2010) NRW advice for managing knotweed (NRW, 2019) Welsh government advice on knotweed to community and volunteer groups (Gov.Wales, 2015) Local Government advice Local problems from knotweed (Swansea.Gov, 2019) Eradication programmes Q and A section (Swansea.Gov, n.d.)

A3: Perceptions of knotweed in the urban environment	IAPS are perceived to negatively impact cities through damaging: Ecology Biodiversity Human societies Property prices Transport networks The city as an ecosystem Published literature on perceptions of IAPS in cities, examples 4 concepts that influence perceptions of IAPS in cities Aesthetic Property value Legislation Land-use	B3: Strategic management of knotweed within Swansea	Strategic management policy in Swansea A timeline of strategic management policy in Swansea (Hathaway, 2000)
A4: Perceptions of risk from knotweed	Risk perceptions from IAPS to human health and wellbeing Risk perceptions from IAPS to native plants and animals Risk perceptions from IAPS to 'native' landscape		
A5: Perceptions of knotweed in the media	Techniques of journalism and perceptions of IAPS Headline choice and perceptions of IAPS Property devaluation from knotweed in the media Legal disputes over knotweed in the media Inaccurate IAPS reporting in the media		

CHAPTER 3: METHODOLOGY

3.1: Introduction

The research used an exploratory case study approach in order to establish perceptions of knotweed within Swansea City.

Before undertaking this research, various methodologies were considered in order to achieve the objectives. Research techniques were considered that measured perception from the field of psychology, however these techniques were excluded due to the focus of research being on environmental management issues. Alternative approaches were considered such as grounded theory and survey work but were excluded due to their potential to cause bias in this context (Fowler, 2012).

An exploratory case study methodology was selected as they are usually applied to small geographical areas and use a limited number of participants as a sample (Zainal, 2007).

An online questionnaire was created and circulated, and semi-structured interviews were undertaken.

This chapter will:

- Define the boundaries of the study area
- Describe and justify the selected methodology
- Examine the ethical considerations
- Describe the techniques used for data collection
- Describe the tools used for data analysis
- Recognise the limitations of the methodology

3.2: The study area

Swansea City is an urban conurbation located at 51.635°N 3.851°W in South Wales, United Kingdom. The area consists of several urban districts surrounding Swansea's City centre (CBD) and Swansea Valley. Swansea City had an estimated population of 300,352 people in the last census in 2011 and is the third most populated urban conurbation in Wales (The Office for National Statistics, 2011).

3.3: The research method

In the published literature it was reported that qualitative techniques are more effective at explaining the underlying thoughts and reasons behind a phenomenon such as perception. Quantitative research was more effective at identifying specific features, classifying data and applying statistical models in order to understand a phenomenon (Postgrad.com.n.d.).

Initially it was considered that this research into perceptions would be predominantly a qualitative study using models of thematic analysis. However after careful evaluation of the published literature the author selected a mix of quantitative and qualitative interviewing techniques as this was more appropriate for identifying perceptions.

After consideration an exploratory case study methodology was selected which help explore a complex phenomenon such as perception (Yin, 2003). Exploratory case studies *“explore those situations in which the intervention being evaluated has no clear, single set of outcomes”* (cited in Tellis, 2003:2).

When using exploratory case study techniques the researcher starts with no pre-conceived conceptions of how the case study will unfold. The reported strengths and drawbacks of using an exploratory case study approach found in the selected literature are summarised below:

Table 2: Strengths and drawbacks of using case studies.

Strengths	Drawbacks
All data is analysed in context with the exploratory case study	It lacks rigour
It allows a combination of qualitative and quantitative research	It generally only uses a small number of participants
It provides detailed descriptions of all data collected	It lacks applicability outside the parameters of the research
It explains complexities of real-life situations that cannot be explained through survey or experimental research	It can be long and complex It can produce an excessive amount of documentation

Source: Adapted from Yin 1984; Zainal, 2007

Once the methodology was selected the target population for establishing perceptions needed to be identified. It was identified that all persons from 18 years of age and above that work within Swansea City would be included in the research.

Conservation volunteers were selected as exploratory case study participants because of the published evidence of their keen interest in the environment and conservation issues as opposed to members of the general public (Fischer *et al.*, 2014; Pagès *et al.*, 2019).

Swansea Council for Voluntary Services (SCVS), which is an organisation which co-ordinates volunteering activities, was approached to provide a list of conservation organisations that operate within the Swansea City area (scvs.org.uk, n.d.). In total twenty organisations that offered conservation volunteering opportunities in Swansea were identified and contacted by email inviting participation in the research.

From responses to the emails it was established that there was a conservation volunteer population of 543 people in Swansea City at the time of the research. This information enabled power calculations to establish a sample size to be undertaken for the online questionnaires (Fugard & Potts, 2015). A power calculation was used and it was found that a sample size of 82 responses was required from all volunteering organisations (Fugard & Potts, 2015).

Volunteers from twenty-one organisations participated in the questionnaire. Figure 5 shows the organisations that respondents volunteered with. The results indicated that the majority 33 respondents (39%) were from the National Trust and other organisations (36%). Hard to reach groups such as volunteers from Swansea Community Farm and Down to Earth Project yielded lower response rates.

Which organisation do you volunteer with in the City and County of Swansea?

[More Details](#)

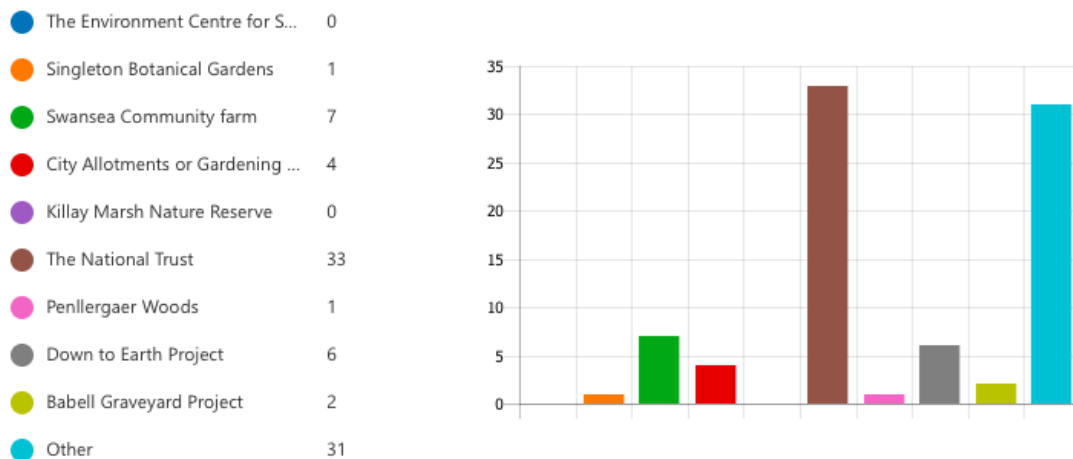


Figure 5: Which organisation do you volunteer with in the City of Swansea?

3.4: Ethical considerations

Baez (2002) had emphasised that confidentiality within any research project means to:

“Protect the privacy of all persons, to build trust and rapport with the study participants, and to maintain the ethical standards and integrity of the research process” (Baez, 2003:35).

When undertaking any research project, it was important to consider participants as individuals that are capable of expressing their experiences, beliefs, values and opinions (Orb *et al.*, 2001; Lopez and Whitehead, 2013).

Prior to undertaking this research, advice was sought from the dissertation supervisor whether ethical approval was required from the University’s ethics committee. Published guidance was also reviewed which led the author to conclude that ethical approval was not required for this research due to:

- Participants were all over eighteen years of age therefore legally were able to give consent
- Participation was voluntary
- Participants responses were to be anonymous

Consent was sought from interviewees prior to any recording due to data protection regulations.

3.5: Techniques used for data collection

The methodology technique selected was:

1. Key themes from the literature review was analysed
2. Pilot study of online questionnaire was undertaken
3. Final online questionnaire was developed
4. Questionnaire responses were analysed
5. Semi-structured interview were designed from questionnaire responses
6. Common themes from the interviews were grouped
7. Interview information was summarised in a appendix D

3.6: Sampling size of online questionnaire

When using an exploratory case study approach, there is no predetermined sample size. Rather the aim of the sampling method was to gather enough samples in order to reach a point of 'saturation' which was often determined by the researcher (Sandelowski, 1995; Marshall, 1996).

However to address any ambiguities in 'saturation', a sample size was calculated using a power analysis tool that provided a 95% statistically significant result. Power tools have become common place for researchers but prescribed models to calculate power are lacking for an exploratory case studies into perceptions (Fugard & Potts, 2015). However Fugard and Potts (2015) had published a cited paper which described a power calculation model that was a useful and pragmatic support tool for studies using thematic analysis so the author adopted this tool.

Due to time constraints it was impractical to sample all conservation volunteers in Swansea City. Therefore, selecting a representative sample that is reflective of conservation volunteers' perceptions of knotweed was required (Lopez & Whitehead, 2013).

The City of Swansea had an estimated Conservation volunteer population of 543 volunteers. In order to get a statistically significant result of 95% confidence level, it was calculated that a minimum sample size of 82 responses was required for the online questionnaire (Fugard & Potts, 2015).

Non-probability sampling was a method used in a wide array of qualitative research (Green & Thorogood, 2009; Lopez & Whitehead, 2013). When using non-probability sampling, the researcher only targets a specific population to investigate a specific topic, in this case the target population being conservation volunteers in Swansea City and the topic being perception.

A form of snowball sampling was chosen as the most appropriate sampling method as it typically used one or more agents to connect the researcher with the target population (Green & Thorogood, 2009). In the research the snowball sampling agents used were SCVS, the organisations identified in Figure 5 and a knotweed specialist (Green & Thorogood, 2009).

3.7: Initial pilot study

Pilot studies have been demonstrated to be a vital part of a study's design process and increased the likelihood of success (Van Teijlingen & Hundley, 2002). A pilot study of the questionnaire was undertaken in October 2019 to test participants understanding of the questions and the suitability of responses. The pilot study had 11 responses and the final design of the questionnaire was modified as a result of the pilot's analysis. The analysis of the pilot is shown in the appendix A.

3.8: Final online questionnaire design

In preparation for the final design of the questionnaire, a table was developed that identified key themes from selected papers in the literature review (*see Table 1*). It was decided to use a questionnaire based upon previous research in Cape Town, South Africa (Potgieter *et al.*, 2019) and in three cities in Switzerland (Lindermann-Mattis, 2016). The questionnaire's design was also influenced by a study on biological control from the Centre for Agriculture and Bioscience International (CABI, 2019).

A total of 30 questions were developed based on the findings of the selected literature and pilot study. The questions developed were included in the design of both the questionnaire and semi-structured interviews (Proctor, 2018).

Empirical studies have shown that questionnaires often yield low response rates (Boynton & Greenhalgh, 2004). Low response rates were often due to questionnaires

being too long or complex. The final questionnaire was designed to not exceed 20 minutes to complete and the wording of the majority of questions were kept to a maximum of 12 words or less (Boynton & Greenhalgh, 2004).

The final online questionnaire comprised of thirty questions, with a mixture of open and closed-ended questions and has been included in appendix B. Microsoft Forms software was chosen to deliver the final online questionnaire and was structured in three sections adapted from Potgieter *et al.*, (2019) model. These sections collected:

- A: Socio-demographic information
- B: Perceptions of knotweed
- C: Management of knotweed

The final online questionnaire was initially circulated in November 2019 to thirteen organisations including those identified in Figure 5. All responses from the questionnaire were analysed through Microsoft Forms and then placed on an Microsoft Excel spreadsheet for further statistical analysis.

3.9: Semi-structured interview design

Pagès *et al.*, (2019) found in the UK that knotweed specialists and conservation volunteers shared similar perceptions about the threats of IAPS on native wildlife, landscape and habitats. However their perceptions differed around the best way to manage IAPS.

The purpose of the semi-structured interviews was:

- To test Pagès *et al.*, (2019) theory that there were differing perceptions between conservation volunteers and knotweed management specialists in terms of threats and management
- To provide further insight and understanding to the online questionnaire responses

Due to time constraints, six informal semi-structured interviews were undertaken between 1st of December and 31st of December 2019. Three of the semi-structured interviews were undertaken with randomly selected participants from questionnaire. The other three semi-structured interviews were with knotweed management

specialists. The specialists selected included the Knotweed Officer for Swansea Council, the Director of a local Knotweed control company and the Project Officer from an LNR.

Each semi-structured interview followed a standard script and lasted approximately 15 minutes. Open-ended questions were formulated to probe respondent's thoughts and opinions on the six key themes. The six key themes were identified from the responses given in response to the online questionnaire. Three themes were designed to identify perceptions of knotweed and three themes to identify the views on knotweed management. The interview script has been included in the appendix C.

Themes of perceptions:

- Theme 1: How much of a threat is knotweed to Swansea's natural beauty?
- Theme 2: To what extent do you think the media influences your perception of Knotweed?
- Theme 3: Has your perception of Japanese knotweed changed over time?

Themes of knotweed management:

- Theme 4: Do you think the damage, disruption and problems caused by knotweed are worse than other invasive plants such as Buddleia or Himalayan Balsam?
- Theme 5: To what extent do you agree that Swansea Council offers effective advice for managing knotweed?
- Theme 6: To what extent do you agree that knotweed is generally managed effectively in Swansea?

With permission from the interviewees, recording equipment was used to transcribe the interviews. Then summarised responses were identified, common themes were clustered and presented in appendix D.

3.10: Data analysis tools

The online questionnaire's responses were analysed using Microsoft Forms and the results were placed on a Microsoft Excel spreadsheet for statistical analysis. Results were displayed in pivot tables using Excel.

The semi-structured interview were recorded using Voice Memos and the results placed on a Microsoft Word table. Common themes were clustered and analysed.

3.11: The application of a conceptual framework by Shackleton et al. (2019) to the identified perceptions

Shackleton et al., (2019) had produced a synthesis of six factors that influence perception of INNS. The authors had described the underlying factors that influenced the six key factors. They summarised their findings in a conceptual framework that was then applied to both the online questionnaire and semi-structured interview findings.

3.12: Limitations of the methodology

All studies are subject to limitations within the methods (Labaree, 2009). The limitations of the selected methodology included:

- The research was limited by time, resources and financial constraints
- The methodology was limited to conservation volunteers who are computer literate and comfortable responding to online questionnaires
- The methodology used for recording the semi-structured interviews was not acceptable for one interviewee
- The participants may not have been a representative sample of the true perceptions of knotweed in Swansea City

CHAPTER 4: RESULTS AND DISCUSSION

4.1: Introduction

The online questionnaire yielded 87 responses which was statistically significant (95% confidence level). The questionnaire's design was not overly long or complex therefore leading to a good response rate (Boynton & Greenhalgh, 2004). Respondents took an average of 19.27 minutes to complete.

Two responses were discarded as they were submitted by respondents who didn't volunteer therefore not meeting the criteria for inclusion for the research.

Six face-to-face semi-structured interviews were carried out with three randomly selected volunteer participants from the questionnaire and three with knotweed management specialists summarised in appendix D.

The chapter presents the results and discusses the data collected through the online questionnaires and semi-structured interviews. It also establishes and discusses the conservation volunteers perceptions of knotweed with the application and evaluation of the perceptions using Shackleton *et al.*, (2019) conceptual framework (see *Figures 1 and 2*).

The chapter explores each primary factor and the underlying sub-factors in Shackleton *et al.*, (2019) conceptual framework. Each primary factor and sub-factor was then evaluated in turn and discussed together with the findings of the literature review. Some sub-factors were correlated using Fischer's exact test and P-values calculated to identify any potential patterns found in the results. Fischer's exact test was chosen due to the small sample size (Lowry, n.d.).

4.2: Discussion of the six primary factors that influence perceptions of INNS

4.2.1: Sub-factors within the individual

All of the primary factors of perception in Shackleton *et al.*, (2019) conceptual model are interlinked. Once established, perceptions are not static but changeable and are dependent on an individual's environment and life experiences (Starfinger *et al.*, 2003).

The results found in the research are only valid in the context of the responses to the online questionnaire and semi-structured interviews and are not be applicable to other locations or studies into perceptions of IAPS (Woodford *et al.*, 2016).

Due to time constraints, not all of the sub-factors identified in Shackleton *et al.*, (2019) conceptual framework were examined within the research.

The first sub-factor examined in the research was demographic characteristics. Demographic characteristics within respondents are used as proxies that can influence individual perceptions. These can be intrinsic and are linked to identity and culture (Bremner & Park, 2007).

Respondents were grouped between the ages of 18 and 65 or above. The results are shown below:

What is your age group?

[More Details](#)

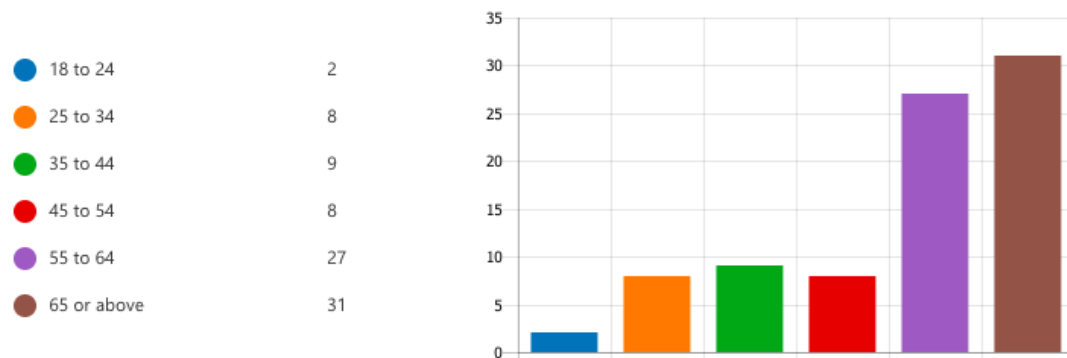


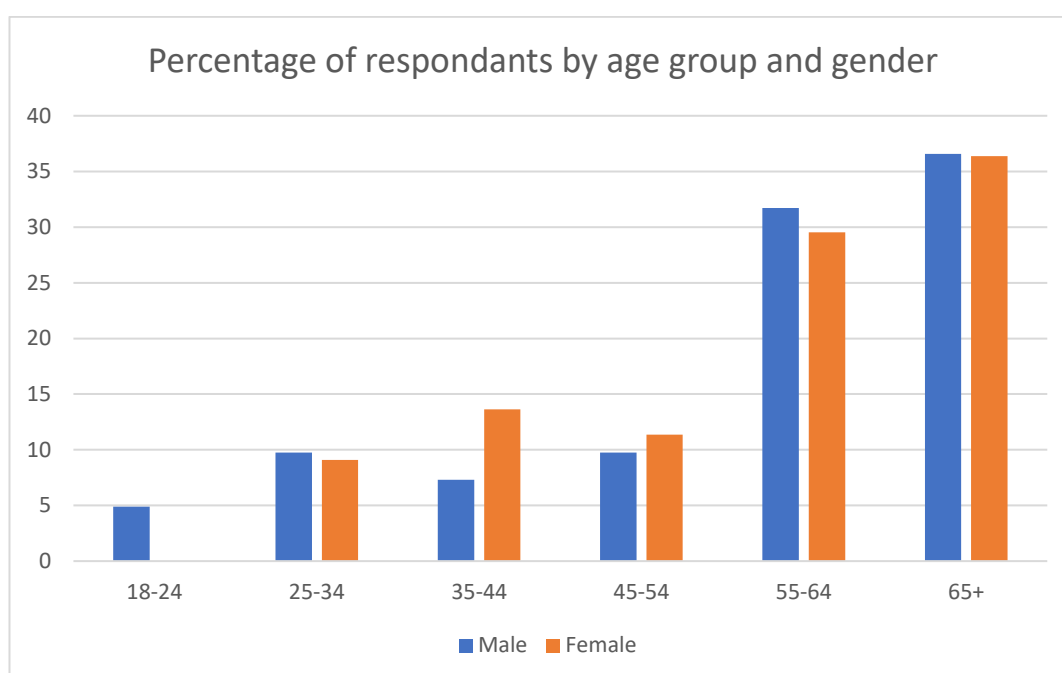
Figure 6: What is your age group?

The most frequent age group was the 65 and above with 36% of respondents within this age category, the least frequent group being 18 -24 years of age. It was expected that respondents were generally older with the most likely age group to volunteer in the UK being 65 to 74 (NCVO, 2019).

A report by the National Council for Voluntary Organisations (NCVO) found that “Across different age groups, 25-34-year olds are least likely to volunteer and 65-74-year-olds most likely” (NCVO, 2019:1). The results demonstrated that the demographic sample size of the research matched those of UK demographic volunteers age patterns.

A breakdown of respondents gender found that of 85 respondents, 52% were female and 48% male. The results agreed with the report by the NCVO which highlighted that women are more likely to volunteer than men.

A breakdown of the percentage of respondents by age group and gender is shown below:



Key:

Age Group	Male (%)	Female (%)
18-24	4.88	0
25-34	9.76	9.09
35- 44	7.32	13.64
45-54	9.76	11.36
55 – 64	31.71	29.55
+65	36.59	36.36

Figure 7: Percentage of respondents by age group and gender.

When asked to describe their ethnicity, 84/85 respondents described their ethnicity as white. Sub-factors such as social structures including a lack of diversity in volunteers (e.g. race, gender and ethnicity) can shape how people perceive and are affected by IAP's invasions (Norgaard, 2007). Studies from the United States into the diversity of workers in the environmental sector (including volunteers), showed that there was an imbalance towards older white men (Taylor, 2014). The results of the

research indicated a lack of diversity in the volunteers surveyed which compared well with the US study by Taylor.

Respondents were asked to list their occupation. 44% of respondents described themselves as retired. The remaining 56% had a broad range of occupations with some working in the environmental sectors (describing themselves as 'ranger' and 'woodsman'), others were from unrelated occupations including a fishmonger and an artist. Most respondents from the online questionnaire were retired professionals.

There was consensus in the literature that retired professionals were becoming increasingly selected as volunteers by agencies (Ockenden, 2007). The pattern of selective recruitment reinforced the existing challenges regarding the lack of diversity in the age and ethnicity of environmental volunteers in the UK.

Respondents were asked to describe their level of knowledge of knotweed. The results are shown below:

How would you describe your level of knowledge of Japanese knotweed?

[More Details](#)

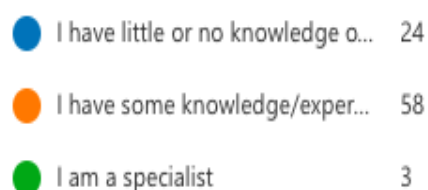


Figure 8: How would you describe your level of knowledge of Knotweed?

Another sub-factor identified by Shackleton *et al.*, (2019) is how experiences of an IAP species and its effects can influence perceptions. When respondents were asked to describe their level of experience of knotweed (*Figure 8*), the results showed that only 3% of respondents described themselves as specialist's, 68% had some experience and 29% had little or no experience. The literature review found an increasing number of organisation's were involved in managing IAPS (Pagès *et al.*,

2019). The finding suggests that more people would have greater experience of knotweed and its effects.

Respondents were asked if their perceptions of knotweed had changed over time. The results are shown below:

. Has your perception of Japanese knotweed changed over time?

[More Details](#)



Figure 9: Has your perception of knotweed changed over time?

The results from 85 responses, 24% of respondent's perceptions completely changed. 40% of respondent's perception slightly changed. 29% of respondent's perceptions remained the same. Only 6% of respondent's perceptions didn't change and the rest didn't know. The results did not indicate any major trend over time, although 40% of participants views slightly changed over time.

In the semi-structured interviews, two interviewees perceptions had changed over time, whilst four interviewees perceptions hadn't changed. Two of three specialist's reported they had changing perceptions, sometimes on a daily basis. All three volunteers perceptions of knotweed hasn't changed. The common responses to this question were:

Table 3: Common responses to theme 3.

Topic	Number of responses
• Childhood memories of knotweed	//
• Perceptions based on the impacts of knotweed	//
• Perceptions based on positive interaction's with stakeholders	//

The literature review found that perceptions of IAPS changed over time (Starfinger *et al.*, 2003). Perceptions of IAPS were influenced by globalized processes examined in theme A2 of the literature review (Trudgill, 2008). The ambition to maintain a 'known' environment can create negative perceptions of IAPS which are sometimes considered as the agents of change (Shackleton *et al.*, 2019). The results of the semi-structured interviews were similar to the results of the online questionnaire in how respondents perceptions changed over time.

Respondents were asked how proud they were to volunteer in Swansea on a scale of 1-10 with 0 being not proud and 10 being extremely proud. An average score of 7.65 indicated that respondents were proud to volunteer in Swansea City.

Table 4: How proud are you to volunteer in Swansea?

Mean (Average)	7.658
Median	8
Range	10
Mode	10, appeared 27 times
Geometric Mean	0
Largest	10
Smallest	0
Sum	651
Count	85

A strong sense of place was another sub-factor that influenced perceptions in the individual (Shackleton *et al.*, 2019). A strong sense of place has been shaped by social, cultural and psychological aspects and is linked to how a person perceives the 'native' landscape (Gaertner *et al.*, 2017). When asked how proud respondents are to volunteer in Swansea City, the results showed respondents were very proud of volunteering in Swansea indicating a strong sense of place and identity.

In order to understand and test perception within the individual(s) a comparison was made between the results of:

- Question 7: How proud are you to volunteer in Swansea?
- Question 14: How much of a threat is knotweed to Swansea's natural beauty?

Proudness (Q7) and threat level (Q14) were subdivided into three categories low (scores 0-2), medium (3-6) and high (7-10). Using Fischer's exact test there was found to be a 5% significance level between the row and column variables.

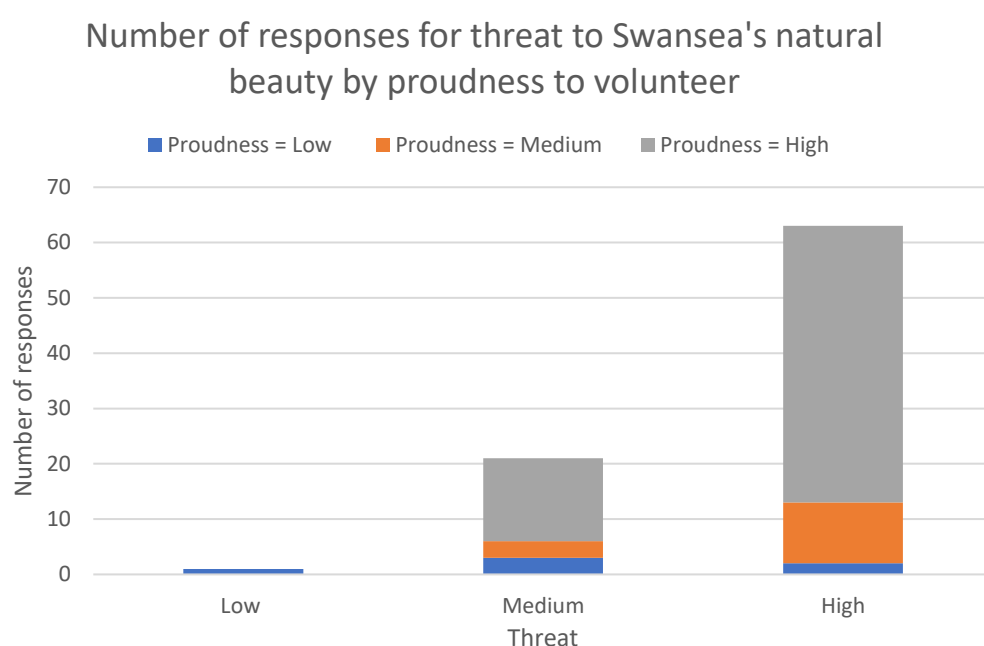


Figure 10: Number of responses for threat to Swansea's natural beauty by proudness to volunteer.

Table 5: Percentage of responses for proudness/threat in low, medium and high scores.

	Threat						Total	
	Low		Medium		High			
Proudness	number	%	Number	%	number	%	number	%
Low	1	100.0	3	14.3	2	3.2	6	7.1
Medium	0	0.0	3	14.3	11	17.5	14	16.5
High	0	0.0	15	71.4	50	79.4	65	76.5
	1	100	21	100	63	100.0	85	100

It was found that respondents who were prouder of volunteering also perceived knotweed as a greater threat to Swansea's natural beauty. The results agreed with findings in the literature that the perceived threat from IAPS is linked to an individual sense of place and experience of the species and its effects (Lindermann-Matties, 2016; Shackleton et al., 2019).

The overall results of testing the perceived sub-factors within the individual(s) (including demographic characteristics, experience of the species and its effects and sense of place **agreed well** with consensus within the literature review.

4.2.2: Sub-factors within the species

Within the literature it was found that perceptions of a species were attributed to traits within the species itself including taxonomic and functional characteristics (Shackleton *et al.*, 2019). Perceptions within the species were also influenced by ethical values such as plant or animal welfare (Warburton & Norton 2009). In addition historical factors such as why and when a species was introduced and how quickly it spread (Bailey & Connelly, 2000).

The first sub-factor examined was introduction status. Respondents were asked in the questionnaire why they thought knotweed was first introduced into the UK. A clear majority (71%) knew that knotweed was first introduced as an ornamental plant indicating knowledge of the introduction status (Bailey & Connelly, 2000).

Shackleton *et al.*, (2007) emphasised that species with useful traits to people were more likely to evoke positive perceptions. Knotweed was originally introduced by the Victorians as an ornamental garden plant in the early 19th century and was considered a valuable addition to a garden (Bailey & Connelly, 2000). The results showed that respondents were aware of initial positive perceptions of knotweed amongst Victorian society. The results of the research agree with the known introduction in the literature.

The next sub-factor examined was the length of time knotweed has been in residence in the UK. Respondents were also asked to estimate the year of introduction of knotweed in the UK. The average year of introduction was estimated at 1859. The

Figure 11 demonstrated the distribution of responses amongst male, female and all persons:

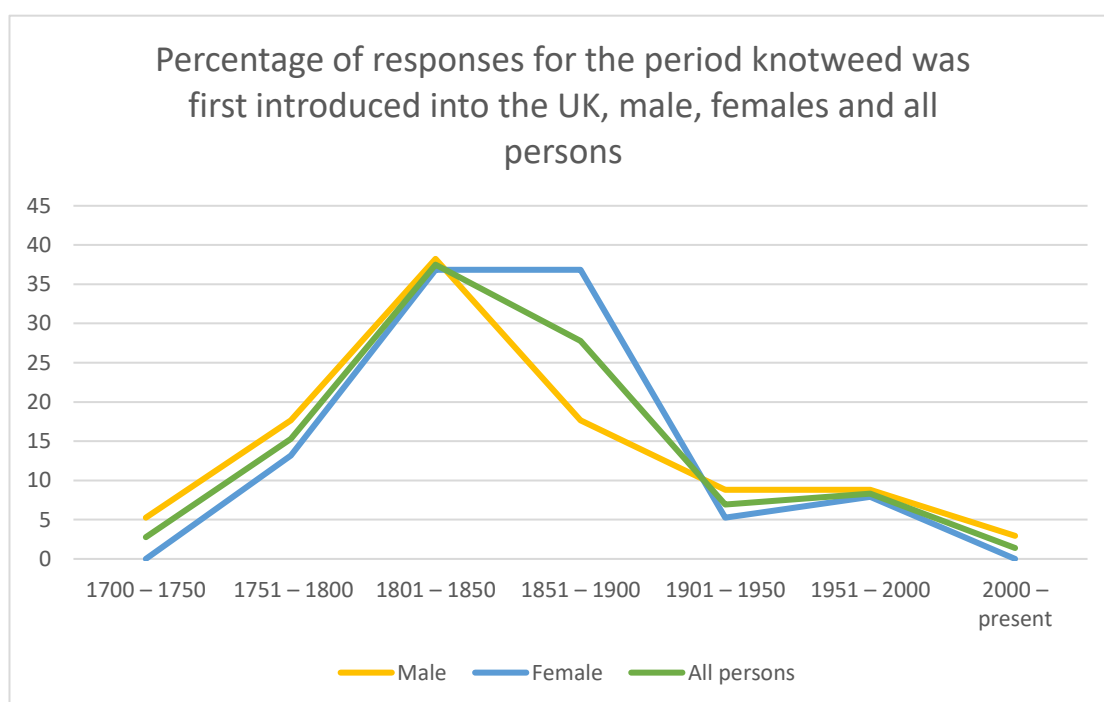


Figure 11: Percentage of responses for the period knotweed was introduced into the UK from all persons.

Table 6: Percentage of responses for each time category.

	Number			Percentage		
	Male	Female	All persons	Male	Female	All persons
1700 – 1750	2	0	2	5.3	0.0	2.8
1751 – 1800	6	5	11	17.6	13.2	15.3
1801 – 1850	13	14	27	38.2	36.8	37.5
1851 – 1900	6	14	20	17.6	36.8	27.8
1901 – 1950	3	2	5	8.8	5.3	6.9
1951 – 2000	3	3	6	8.8	7.9	8.3
2000 – present	1	0	1	2.9	0.0	1.4
Total	34	38	72	100.0	100.0	100.0

Figure 11 only included those with a valid response, with the number of respondents who didn't answer correctly as 13/95 (15%) of respondents. Nearly 40% of respondents estimated that knotweed was introduced between 1801 and 1850 with the average year of introduction as 1859 which suggests that respondents were aware of when the species was introduced.

In the literature Garcia-Llorente *et al.*, (2018) argued that IAS with longer residence times are more likely to be perceived as native and part of the collective social memory. There was a discrepancy within the literature over the exact date of introduction for knotweed in the UK with the earliest date found as 1825 (Bailey & Connelly, 2000).

The final sub-factor examined was traits within the species. Two questions were asked in the online questionnaire to test respondents' perceptions of the sub-factor. When asked how long a knotweed plant lived, 78% of respondents thought it was a perennial plant.



Figure 12: How long does a knotweed plant live for?

The results indicated a strong awareness amongst participants of the lifecycle of the plant, whilst also suggested that respondents knew that knotweed was long-lived. Knotweed has been documented in the literature to be a vigorous perennial plant (Fennell *et al.*, 2018: RHS.org, 2019).

In the second question to test perceptions of traits within the species, respondents were asked how quickly thought a knotweed plant can grow daily in its peak season in July. The mean, medium and mode has been calculated:

Table 7: How quickly do you think knotweed grows per day in its peak growing season of July?

Mean (Average)	4.058
Median	3
Range	10
Mode	3, appeared 22 times
Geometric Mean	0
Largest	10
Smallest	0
Sum	345
Count	85

The results showed that the respondents thought knotweed grew an average of 10cm per day. The Environment Agency has described knotweed as ‘the UK’s most aggressive, destructive and invasive plant’ (Environment Agency, 2010). Although not as fast growing as other IAP species such as bamboo (Zhi *et al.*, 2005), knotweed has been estimated to grow 10cm per day in summer (Environment Agency, 2010). Respondents reported understanding of traits within the species agreed well with the literature.

In order to understand how respondents perceived the species, a correlation was made between the perceived sub-factors of introduction status and traits within the species using Fischer’s exact test. The below questions were used for this correlation:

- Question 10: Why was knotweed first introduced to the UK?
- Question 13: How quickly do you think knotweed grows per day in July?

The estimated growth of knotweed in centimetres was compared with why respondents thought knotweed was first introduced into the UK for the three most frequent responses. There was no statistical significance found between row and column variables.

Table 8: Growth (cm) and introduction status.

Growth (cm)	Why was knotweed Introduced to UK?						Total	
	Ornamental plant		Use on railways		I don't know			
	N	%	n	%	N	%	N	%
0	0	0.0		0.0	1	8.3	1	1.2
1-3	6	9.8	3	25.0	2	16.7	11	12.9
4-6	11	18.0	3	25.0	2	16.7	16	18.8
7-9	17	27.9	2	16.7	3	25.0	22	25.9
10-12	4	6.6	1	8.3	0	0.0	5	5.9
13-15	8	13.1	0	0.0	1	8.3	9	10.6
16-18	3	4.9	1	8.3	0	0.0	4	4.7
19-21	1	1.6	0	0.0	1	8.3	2	2.4
22-24	3	4.9	1	8.3	2	16.7	6	7.1
25-27	4	6.6	1	8.3	0	0.0	5	5.9
30+	4	6.6	0	0.0	0	0.0	4	4.7
Total	61	100	12	100	12	100	85	100

The correlation found that 61/85 of respondents knew that knotweed was introduced as an ornamental plant, of which almost a third incorrectly estimated its growth rate as between 7-9 cm. In comparison 3/12 of respondents who didn't know why knotweed was introduced into the UK also incorrectly estimated growth as between 7-9 cm. There was insufficient data to support a correlation between historical factors i.e. why knotweed was introduced and functional characteristics i.e. growth rate of knotweed.

The overall results of testing the perceived sub-factors within the species (including introduction status, residence time and species traits) **agreed well** with consensus found within the literature review.

4.2.3: Sub-factors within the effects (potential and realised)

Vaz *et al.*, (2017) have defined the effects of IAS as changes to both human-social and ecological systems as a result of IAS invasion. They reported that people perceived the effects of IAPS as either positive, neutral or negative and were dependent on economic, ecological and social implications specific to an individual IAP species. Shackleton *et al.*, (2019) also reported that these effects were dependant on an individual's values.

The online questionnaire was designed to encompass the three sub-factors of economic, ecological and social effects in all questions because they are so closely interconnected and are not independent of each other. Consequently the discussion grouped these three sub-factors together as a whole.

Respondents were asked to what extent does knotweed impact on their life with 0 being not at all and 10 having a major impact. A mean, median and range calculation was undertaken and found that the median and mode of the data was 2 indicating a low level of impact:

Table 9: In your opinion to what extent does knotweed impact upon your life?

Mean (Average)	2.870
Median	2
Range	9
Mode	1,2, each appeared 15 times
Geometric Mean	0
Largest	9
Smallest	0
Sum	244
Count	85

The purpose of the question was to understand respondents' perceptions of risk (i.e. life impact). The results demonstrated a perceived low level of risk from knotweed, suggesting not all the perceived risks associated with the IAP cause an imminent danger to humans and agreed well with the literature (Rotherham, 2005; Robinson *et al.*, 2017).

In the online questionnaire, respondents were also given three statements to test their understanding of the effects of knotweed on human health and wellbeing, plants and animals and to the native landscape.

Choose the best option to describe the following statements. (please mark the box of your preference always, often, seldom, never, I don't know)

[More Details](#)

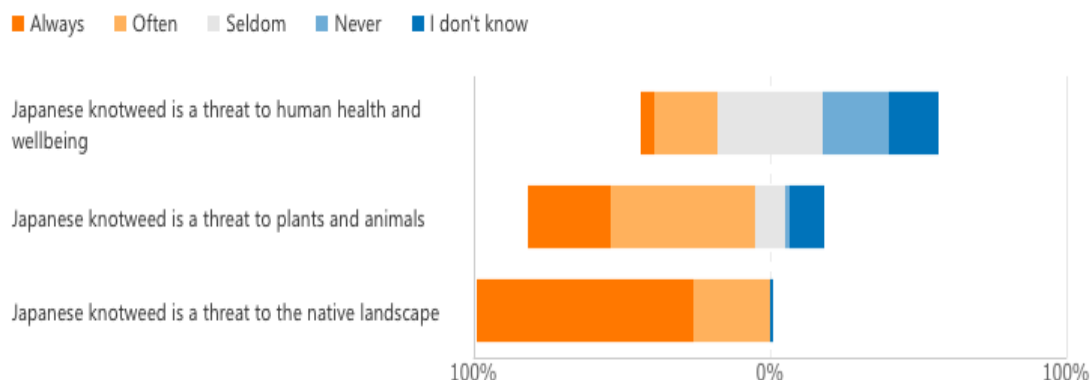


Figure 13: Choose the best option to describe the following statements.

The first and second most popular choices for statement 1 was that knotweed seldom and never was a threat to human health and wellbeing with 35% and 22% of respondents. Only 26% of respondents perceived knotweed as always or often a threat to human health and wellbeing. The result doesn't agree with consensus in the literature that knotweed was a threat to human health and wellbeing (Pimental *et al.*, 2005).

In statement 2, 76% of respondents believed knotweed to be always (28%) or often (48%) a threat to plants and animals. Only 12% of respondents didn't think that knotweed was a threat with 12% of respondents not knowing. IAPS were widely perceived in the literature to have negative impacts on the ecological environments they occupy, including damage to biodiversity within those environments (Brooks *et al.*, 2004; Charles & Dukes, 2008). The result to statement 2 agrees with consensus within the literature review.

In statement 3, 98% of respondents perceived knotweed was always or often a threat to the native landscape. Knotweed is a known threat to the native landscape (Trudgill, 2008).

In a separate questionnaire question, respondents were asked to rate the threat of knotweed to Swansea's natural beauty on a visual analogue scale from one to ten.

The average response was a score of 7.75 suggesting a high perceived impact and the results triangulate with the results of statement 3.

Respondents were asked to rate the following effects of knotweed in cities in terms of importance with 1 being the most important and 5 being the least:

Japanese knotweed is known to negatively impact upon cities by damaging: *Plants *Animals *Human societies *Transport networks *Devaluing house prices Place these impacts in order of importance to you. (use the arrows to select the order)

[More Details](#)

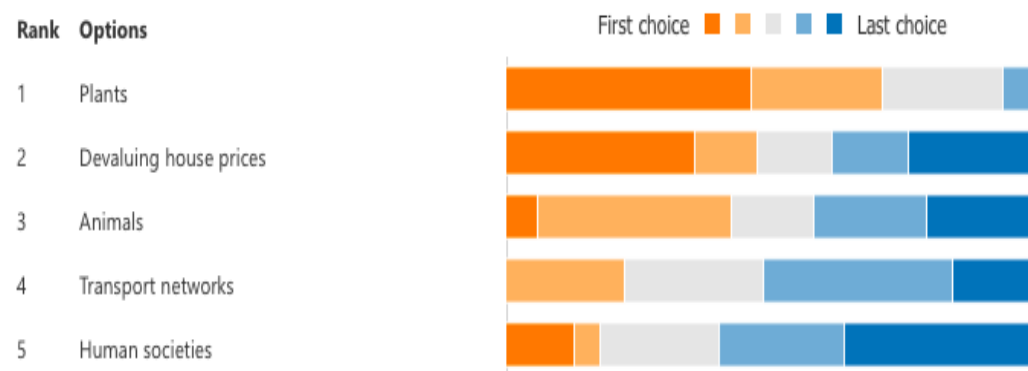


Figure 14: The negative impact of knotweed on cities.

The primary choice of respondents were plants (45.9%), devaluing house prices (35.3%), human societies (12.9%), animals (5.9%) and transport networks (0%). Due to the damaging effects of knotweed on property value in the media, it was expected that devaluing house prices would be the volunteers primary choice (Pagès *et al.*, 2019).

There was a lack of published literature on the perceived effects of IAPS in the urban environment (Payne & Hoxley, 2012; Peat *et al.*, n.d). Theme A3 in the literature review examined how perceptions of IAP's in cities were dependent on the connected factors of aesthetics, property value, legislation and land use. Respondents choice was dependent on the importance of each factor to the individual. Due to lack of published literature on how volunteers perceive knotweed in the urban environment, no correlation was drawn between the results and consensus within the literature.

The research aimed to establish the level of local understanding about the ecological effects of an INNS species. Respondents were asked if they thought that the damage, disruption and problems caused by knotweed were worse than other IAP species. 80% of respondents responded yes to the question.

In the semi-structured interviews, five interviewees didn't think the problems caused by knotweed are worse than other IAP species. All three specialists didn't think that knotweed was worse than other IAPS. The common responses to this category were:

Table 10: Common responses to theme 4.

Topic	Number of responses
• Effects/control of Balsam	III
• Effects/control of Buddleia	II
• Severity of impacts dependant on IAP's locations	II
• Impacts of knotweed on infrastructure	II
• Effects of knotweed on soil	II

The findings of the online questionnaire and interview agree with consensus in the literature that knotweed is a particularly damaging IAP (Maurel *et al.*, 2009; Cottet *et al.*, 2015).

In order to further understand how respondents perceive the effects (potential and realised) of knotweed, a correlation was made between the perceived effects (sub-factors of economic, ecological and social) and the primary factor of the institutional, governance and policy context. This was undertaken because the author wanted to establish any link between the effects of knotweed and perception of advice given by Swansea Council.

Kaur *et al.*, (2014) have argued that the assessment of damage caused by IAPS was dependent on the perceived benefits of a species to biodiversity, ecosystems and wellbeing. Perceptions of IAP species such as knotweed which is often portrayed as having very few benefits (*see Theme 2.2.1*) has also been stigmatised in the media (The Property Voice, 2014).

The below questions were used for the correlation:

- Question 21: Do you think the damage, disruption and problems caused by knotweed are worse than other IAP's?
- Question 28: To what extent does Swansea Council offer effective advice for managing knotweed?

The number and percentage of responses from both questions was compared using Fischer's exact test. There was no statistical significance found between row and column variables.

Table 11: Damage caused by knotweed and effectiveness of advice.

IAP damage	Advice					
	Number			Percentage		
	Yes	No	Total	Yes	No	Total
Bad	0	1	1	0.0	5.9	1.2
Not effective	2	2	4	2.9	11.8	4.7
No opinion	12	1	13	17.6	5.9	15.3
Effective	16	4	20	23.5	23.5	23.5
Very effective	5	0	5	7.4	0.0	5.9
Don't know	33	9	42	48.5	52.9	49.4
Total	68	17	85	100	100	100

Number of responses for whether knotweed damage is worse than other IAP's by the perceptions of effective advice for managing knotweed

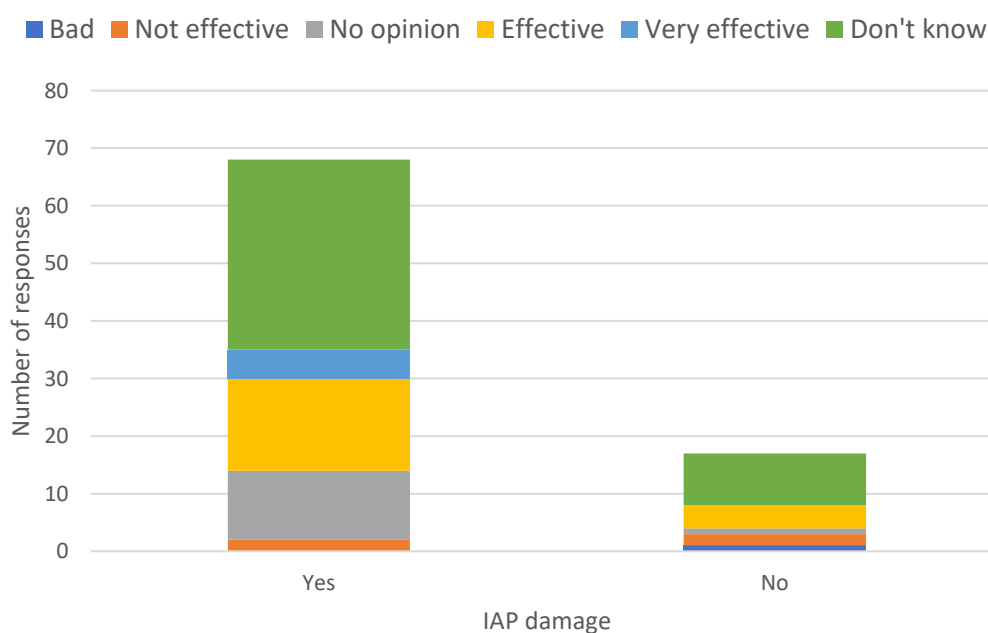


Figure 15: Number of responses for whether knotweed damage is worse than other IAP'S by the perceptions of effective advice for managing knotweed.

Nearly half of respondents who stated that the problems of knotweed were worse than other IAP's also stated that they didn't know how effective the advice was from the council. It was also found that regardless of the effectiveness of advice provided by the council, knotweed was still considered to be more damaging than other IAP's. This suggested that the majority of respondents were unable to make an informed decision on whether knotweed was worse than other IAP's.

The overall results of testing the perceived sub-factors within the effects (including economic, ecological and social effects) **agreed well** with consensus found within the literature review.

4.2.4: Sub-factors within socio-cultural contexts

This primary factor shaped perceptions through interactions between people and rules, traditions, practices and social values (Kull *et al.*, 2011). Socio-cultural contexts are closely linked with other primary factors in the individuals and effects (potential and realised).

The first sub-factor examined was land tenure systems. Shackleton *et al.*, (2019) found that structural factors such as land tenure systems significantly shape perceptions. Studies have found that personal perceptions of knotweed changed significantly when private property is occupied (Urgenson *et al.*, 2013). Theme A5 of the literature review found that half of the sources identified related to the theme of property devaluation from knotweed (The Property Voice, 2014; Humphries, 2018; Wales Online, 2018). Peat *et al.*, n.d).

Respondents were asked if they have considered buying a property with knotweed on the premises. 53 responses (62%) stated that they would not, 32 responses indicated that they would either buy a property or would consider buying. Table 12 highlights some of the reasons behind those choice:

Table 12: Would you or have you considered buying a property with knotweed on the premises?

ID ↑	Name	Responses
1	anonymous	because it is removable, although difficult.
2	anonymous	Because it is treatable, but the estimated cost of treatment would have to be deducted from the price paid, and if there was a mortgage required to purchase the property then there may be difficulty in securing the loan.
3	anonymous	Because(with difficulty) it can be controlled over time. As A property owner one could devote time and energy to dealing with it whereas in large areas like Rosehill Quarry it is almost impossible.
4	anonymous	If it wasn't too invasive on the property and not too close to the structure as it can be treated and got rid of over time

The results were comparable with a survey undertaken by the London Economic Newspaper which found that 32% of British citizens would purchase a property with knotweed on the premises (Peat *et al.*, n.d.).

The next sub-factor examined was management history. Respondents were asked to estimate the percentage of knotweed coverage in Swansea City. On average the respondents estimated the coverage to be 32%.

The literature review identified that Swansea Council published two surveys into the extend of knotweed in Swansea City (Hathaway 2000; Wade *et al.*, 2003). The most recent survey in 1998 found that 26% of Swansea City was covered by knotweed (Hathaway, 2000). Due to the leading nature of the question and due to there being no recent surveys undertaken in Swansea City the results cannot indicate a common consensus between responses and the literature.

The next sub-factor examined was public and media discourse. Respondents were asked if their perceptions of knotweed was influenced by the media:

To what extent do you think that the media influences your perception of Japanese knotweed?

[More Details](#)

Strongly influences me	1
Influences me	22
Not one way or the other/ no ...	23
Doesn't influence me	37
I don't know	2



Figure 16: To what extent do you think the media influences your perception of knotweed?

Responses ranged from strongly influenced me (>1%), 22 responses as influenced me (26%), 23 responses as neutral (27%), 37 (44%) responses as hasn't influenced me and the remaining 2 responses didn't know.

In the semi-structured interviews, five interviewees stated their perception wasn't influenced by the media with one interviewee stating that knotweed isn't prevalent in the media. All three specialist's views were not influenced by the media and two of the volunteers views were not affected by media portrayals. The common responses in this category were:

Table 13: Common responses to theme 2.

Topic	Number of responses
• Media's portrayals on infrastructure damage caused by knotweed	II
• Media portrayals of property devaluation and mortgage problems caused by knotweed	IIII
• Stigmatisation of knotweed in the media	I
• Distorted media portrayals of knotweed	IIII
• Sensationalism of knotweed in the media	III
• Legal issues of knotweed in the media	I

Social values communicated by the media and heightened exposure to some IAS also affect perceptions of IAS (Touza *et al.*, 2014). Theme A5 of the literature review examined perceptions of knotweed in the media. The section found that:

- The media overemphasised the impacts of IAPS to human society
- Choose attention grabbing headlines
- Focused mainly on property-devaluation and legal disputes from knotweed

The results indicated that many respondents reported they were not influenced by social values projected by the media, therefore not complying with the common consensus within the literature review. This suggests the respondents were not influenced by the media due to their keen interest in environmental issues and socio-cultural backgrounds.

The next sub-factor examined was social memory. Social memory is a psychological trait than can help understand perceptions of INNS (Shackleton *et al.*, 2019). Respondents were asked if they have any childhood memories of knotweed. A summary of the responses can be found on the table below:

Table 14: Do you have any childhood memories of knotweed?

15	anonymous	Making pipes to smoke
16	anonymous	Using the stems to make 'javelins'
17	anonymous	Playing with the hollow stem. Pea shooter and whistles.
18	anonymous	As children this was known as "pea shooters" where the hollow stems were cut and played with. It was also know by children as as "Wild Rhubarb" with the stems cut and the juice drunk! At that time in the 1950's It was generally only found on Council owned land.
19	anonymous	My children used to play in it and called it "Sally Rhubarb"
20	anonymous	I remember Knotweed growing in garden next to Sketty Road in Sketty. After attending Saturday morning cinema we broke off and used long mature knotweed stems as pretend guns enacting the heroes seen in the cinema.
21	anonymous	Making dens/ pea-shooters and to drink the water underneath to make you sick.
22	anonymous	No particular memory.
23	anonymous	In tycoch area. Called it wild rhubarb

Only 26 respondents (31%) reported they had memories of knotweed. Despite negative perceptions of knotweed in adulthood, childhood memories tend to be overwhelmingly positive both from an individual memory and collective social memory. Individual memories included making 'dens' and 'peashooters' and eating knotweed (Environet.com, n.d.).

Individual memories, including a collective social memory, are psychological traits that can help understand perceptions of INNS (Shackleton *et al.*, 2019). The results found that childhood social memories were positive, many respondents nicknamed the plant as 'sally rhubarb' and had fond memories of playing with other children in the knotweed. This agreed with consensus within the literature that perceptions of IAPS such as knotweed can change over time (Starfinger *et al.*, 2003).

The final sub-factor examined was social value systems. In this case being the value respondents place on being in natural environments. Respondents were asked to estimate the number of hours they spent in the natural environment per week. The results indicated that 72% of respondents spent 15 hours or less in the natural environment per week.

In the literature, individual social value systems are shaped by and inform broader societal ideologies known as social value systems (Shackleton *et al.*, 2019). These social values are perpetuated by conservation groups who are motivated primarily by a desire to ‘protect and enhance the natural environment’ (Ryan *et al.*, 2001). The research results agreed with the literature that there was a positive correlation between spending time outdoors and a keen interest in the natural world including IAPS (Lindermann-Mattis, 2016; Potgieter *et al.*, 2019).

In order to understand how respondents perceive the socio-cultural context, a correlation was made between the perceived sub-factors of public and media discourse and land-tenure system. This correlation was chosen as a theme was identified in the data. The below questions were used for this correlation:

- Question 17: To what extent do you think the media influences your perception of knotweed?
- Question 18: Would you or have you considered buying a property with knotweed on the premises

Using Fischer’s exact test media influence and property responses was compared. There was no statistical significance found between row and column variables.

Table 15: Media influence and property responses.

Media influence	Property						Total	
	No		Yes		Maybe			
	number	%	number	%	Number	%	Number	%
Strong influence	0	0.0	0	0.0	1	4.5	1	1.2
Influence	18	34.0	0	0.0	4	18.2	22	25.9
No influence	22	41.5	9	90.0	8	36.4	39	45.9
No opinion	12	22.6	1	10.0	8	36.4	21	24.7
Don't know	1	1.9	0	0.0	1	4.5	2	2.4
Total	53	100	10	100	22	100.0	85	100

When comparing the data, 90% of respondents who weren’t influenced by the media would purchase a property with knotweed. Of the respondents who would purchase a property with knotweed almost half were not influenced by the media. This suggests that media portrayals of knotweed had little influence on the volunteers

within the sampled group. In the published literature there was no literature that compared media influences conservation volunteers choice to purchase a property with knotweed.

Another correlation was made between the sub-factors social value systems and social memory. The below questions were used for this correlation:

- Question 22: In your opinion to what extent does knotweed impact upon your life?
- Question 23: Do you have any childhood memories of knotweed?

Life impact was then subdivided into three categories low (scores 0-2), medium (3-6) and high (7-10). The next table summarises the results. Using Fischer's exact test there was no statistical significance found between row and column variables.

Table 16: Childhood memory and life impact.

	Life impact						Total	
	Not at all		Medium		High			
Childhood memory	number	%	number	%	number	%	number	%
No	31	70.5	23	69.7	4	50.0	58	68.2
Yes	12	27.3	10	30.3	4	50.0	26	30.6
Maybe	1	2.3	0	0.0	0	0.0	1	1.2
	44	100	33	100	8	100	85	100

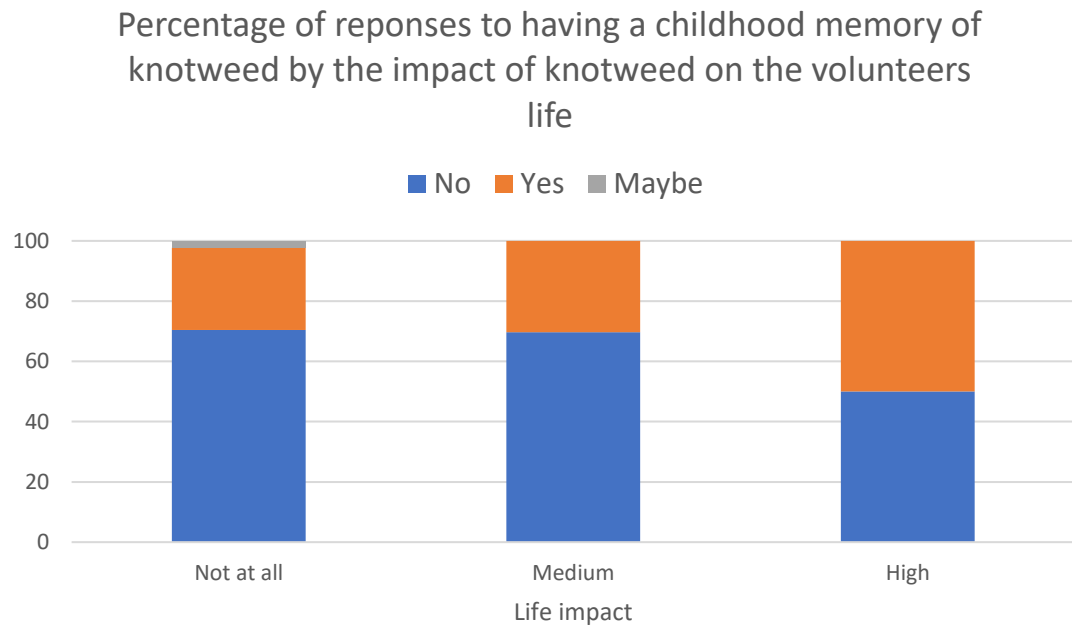


Figure 17: Percentage of responses to having a childhood memory of knotweed by the impact of knotweed on the volunteer's life.

The results showed that almost a third of respondents reported a childhood memory of knotweed, and of these 50% reported to have a high level of life impact. Of respondents who didn't have any childhood memories the distribution of responses was more even. The data shows a correlation between having childhood memories of knotweed and subsequent impact on life. This correlation agreed with consensus in the literature.

The overall results of testing the perceived sub-factors within the socio-cultural context (land tenure system, management history, public and media discourse, social memory and social value systems) **agreed** with consensus within the literature review.

4.2.5: Sub-factors within the landscape context

A landscape is comprised of areas of land containing similar mosaics, elements or ecosystems that reproduce themselves (Shackleton *et al.*, 2019). The three key sub-factors tested in the online questionnaire that shaped perception of landscape were land use and cover, the management history and the attractiveness of the landscape.

Nassauer (1995) and Niemec *et al.*, (2017) argued that perceptions of landscape were viewed through individual eyes and were also influenced by emotional factors such as a sense of place or whether an IAP species was seen as part of the ‘native’ landscape (Trudgill, 2008).

The first sub-factor examined was land use and cover. Respondents were asked in a multiple-choice question what types of land was affected by knotweed in Swansea:

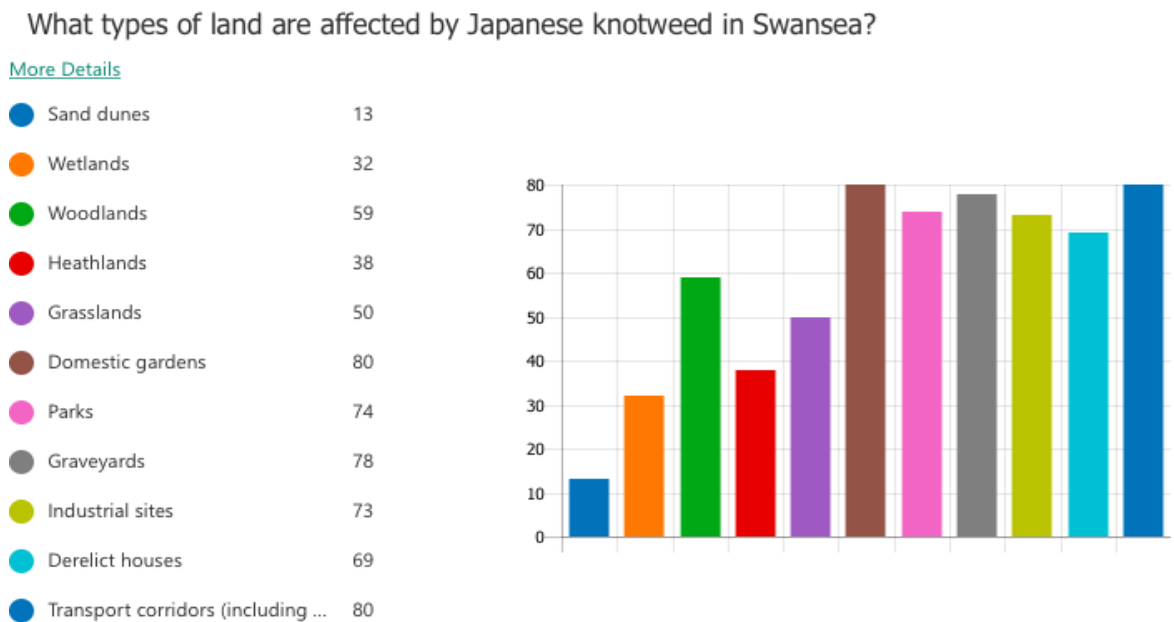


Figure 18: What types of land are affected by knotweed in Swansea?

Of 646 selections, 192 selections (30%) included natural habitats such as woodlands and heathlands. 454 (70%) of selections included human dominated landscapes such as transport corridors and domestic gardens. There was a bias towards selecting human dominated land types.

In the literature review (particularly local government publications) it was evident that knotweed was present in both human dominated and natural habitats and was present in all land types in Swansea (Hathaway, 2000). The research results didn’t agree with consensus within the literature.

The next sub-factor examined was landscape beauty/scenery or attractiveness. The results showed that 98% of respondents perceived knotweed to be always or often

a threat to the native landscape (*statement 3*) and that respondents perceived knotweed to have a high level of impact on Swansea's natural beauty.

In the semi-structured interviews, four of the interviewees considered knotweed to be either a threat or a major threat to Swansea's natural beauty. Two interviewees did not consider knotweed to be a threat. Two specialists and two volunteers considered knotweed a threat. The common responses in this category were:

Table 17: Common responses of theme 1.

Topic	Number of responses
• Knotweed in urban Swansea as opposed to the Gower	III
• Control and management of knotweed	III
• Spread and conurbations of knotweed in Swansea	III

A possible explanation behind these results could be that knotweed is considered an 'ugly' or 'hideous' species (Lindermann-Matthies, 2016). Another explanation could be Swansea's urban setting. The literature review found that perceptions of IAPS in urban environments tend to be more extreme than rural locations (Shackleton *et al.*, 2015). The results agreed with consensus within the literature.

The final sub-factor examined was management history. Respondents were asked to estimate the number of years that knotweed had been managed in Swansea. According to Child *et al.*, (2001), the first active management of knotweed in Swansea was in 1992. The median answer amongst respondents was 20 years of management.

Table 18: How many years has knotweed been managed in Swansea?

Mean (Average)	2.741
Median	2
Range	9
Mode	2, appeared 29 times
Geometric Mean	2.3876556380509
Largest	10
Smallest	1
Sum	233
Count	85

The results indicated that respondents had some awareness of the management history. These results agree with consensus within the literature.

In order to understand how respondents perceived the landscape context, a correlation was made between the perceived sub-factors land use and cover and the primary factor of effects (potential and realised). The below questions were used for this correlation:

- Question 9: How much of a threat is knotweed to human health and wellbeing/plants and animals/native landscape?
- Question 15: What types of land are affected by knotweed in Swansea?

Using Fischer's exact test the number of responses to threat to Swansea and land type selections was compared. There was no statistical significance found between row and column variables.

Table 19: Number of responses for threat to human health and wellbeing/plants and animals/native landscape and land types affected by knotweed in Swansea.

Q9 & 15

		Landtypes									
Q9	Response	1	4	5	6	7	8	9	10	11	Grand Total
Wellbeing	1	1		3		4	1	2	1	2	14
	2		1		2	3	5	2	3	3	19
	3	1	1	6	3	4	7	3	2	3	30
	4			4	4	4		2	1	3	18
	5			1					2	1	4
Plant/animals	1	1		2	1	2	1	1		2	10
	2									1	1
	3		1	1	1	1	3	1	1		9
	4	1	1	9	3	7	6	4	3	7	41
	5			2	4	5	3	3	5	2	24
Landscapes	1	1									1
	4		1	7	2	5	3		1	3	22
	5	1	1	7	7	10	10	9	8	9	62

Number of landtypes selected by element of threat
(always and often threat level only)

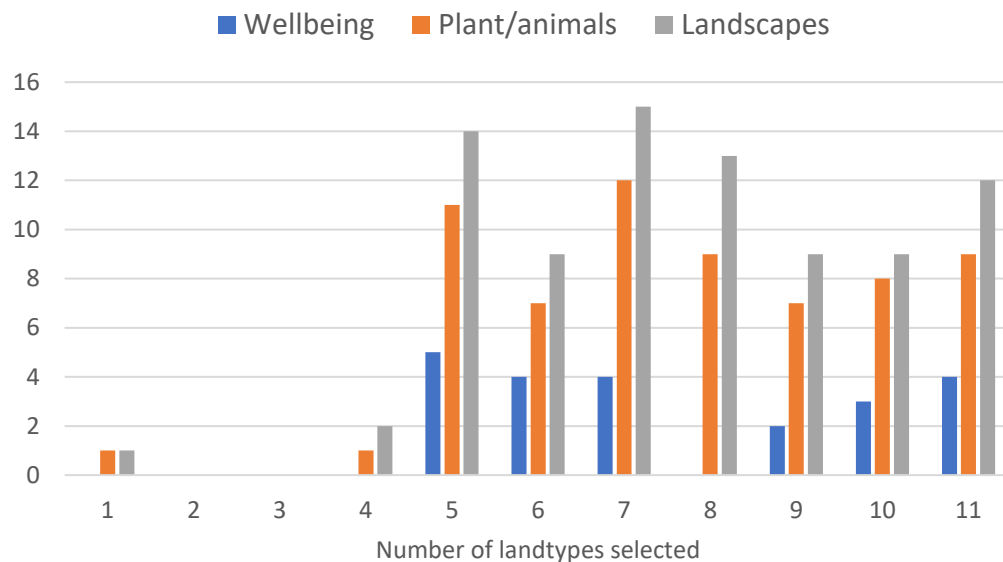


Figure 19: Number of land types selected by element of threat (always and often threat level only).

The results showed that volunteers who perceived knotweed to always or often impact upon plants, animals and the native landscape tended to select more land types occupied by knotweed. This suggests that respondents were more aware of the impacts of knotweed on the natural environment.

The overall results of testing the perceived sub-factors within the landscape context (including land use and cover, landscape beauty or attractiveness and management history) **agreed** with consensus within the literature review.

4.2.6: Sub-factors within the intuitional, governance and policy context

“Policy and governance contexts influence perceptions of IAS through the capacity of institutions to shape individual values, social relationships and to motivate or constrain attitudes and behaviours towards IAS” (Shackleton et al, 2019:20).

This primary factor was closely aligned with the socio-cultural contexts factor discussed previously. Globalised processes have facilitated the spread of IAPS across international boundaries (Robinson, 2016) as discussed in Theme A2 of the literature review.

The first sub-factor examined was institutional frameworks. Respondents were asked who was responsible for managing knotweed in Swansea. The results are shown below:

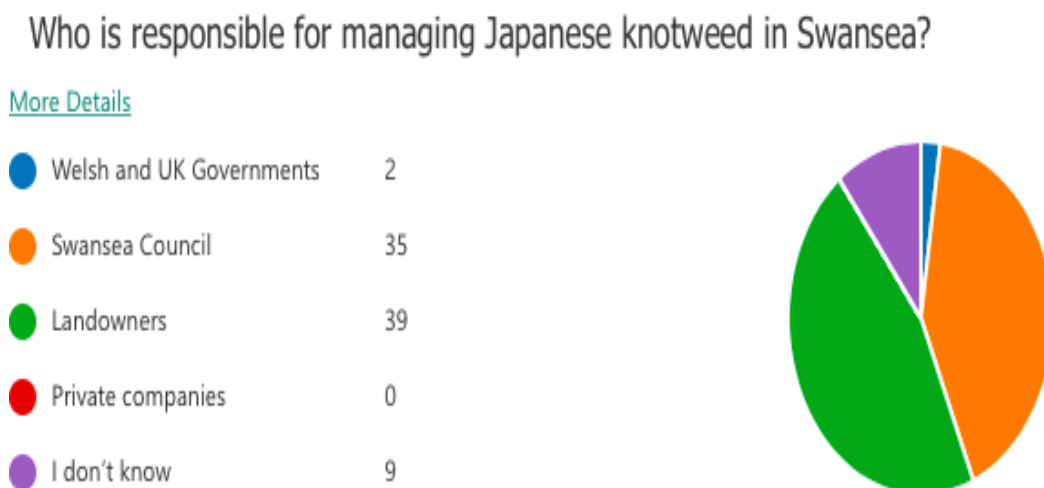


Figure 20: Who is responsible for managing knotweed in Swansea?

The results showed that 46% of respondents selected landowners and 41% selected Swansea Council. Swansea Council’s Nature Conservation team is responsible for managing knotweed within the city (Hathaway, 2000). The results suggest that perceptions of responsibility of knotweed control are unclear amongst the sampled volunteers and thus agrees with consensus in the literature review (Urgenson et al., 2013).

The next sub-factor examined was legislation, regulation and enforcement. Respondents were asked if the appropriate legislation (the Wildlife and Countryside

Act (1981)) had been implemented effectively in Swansea City. The results are shown in Table 11:

Table 20: Under the UK Wildlife and Countryside Act (1981) it is 'illegal to cause knotweed to grow in the wild'. In your opinion to what extent do you agree that the current legislation is effectively applied in Swansea?

Mean (Average)	3.611
Median	4
Range	8
Mode	5, appeared 24 times
Geometric Mean	0
Largest	8
Smallest	0
Sum	307
Count	85

The mean answer was 3.6 which indicated a perceived poor standard of effective implementation in Swansea. The author expected that levels of understanding of the legislation would be low amongst respondents as only specialists understand how effectively the legislation is implemented according to Shackleton *et al.*, (2019). The finding suggested that the sample of volunteers didn't understand the extent of legislation implementation in Swansea. The results agree with consensus in the literature.

The final sub-factor examined was policy and governance strategy. Respondents were asked to what extent does Swansea Council offer effective advice for managing knotweed. The results are summarised:

To what extent does Swansea Council offer effective advice for managing knotweed?

[More Details](#)

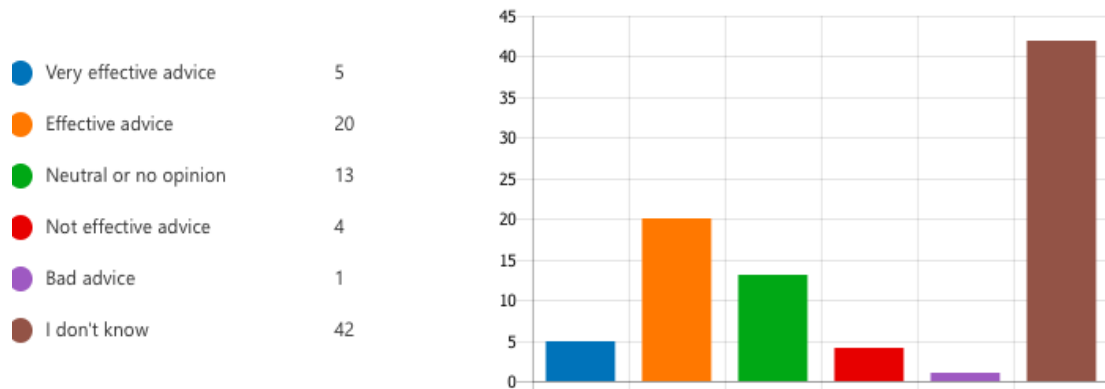


Figure 21: To what extent does Swansea Council offer effective advice for managing knotweed?

The results showed nearly half of respondents to the online questionnaire didn't know what advice was available with a majority of interviewees supporting this finding.

In the semi-structured interviews, 5/6 interviewees had no definitive answer to this question with only one interviewee rating the advice provided as effective. All volunteers and two specialists had limited or no direct experience in dealing with Swansea Council. The common responses to this category were:

Table 21: Common responses to theme 5.

Topic	Number of responses
• The council has a designated knotweed officer	II
• The council's lack of manpower or resources	III
• Treatment schemes for knotweed	II
• Communication channels	III
• Lack of experience dealing with the council	II

In the literature review many sources of useful advice on management of knotweed were published and accessible to the general public (*Theme B2*). Despite these sources of advice the conservation volunteers sampled were unaware of them. There were two possible explanations for this:

- Respondents were unaware of where the advice was located on knotweed from the council
- Respondents didn't have knotweed on their properties

Respondents were also asked if knotweed was managed effectively in Swansea. The respondents were asked to rate the effectiveness of management from 1 to 10 with lower scores indicating poor management and higher scores indicating effective management:

Table 22: To what extent do you agree that knotweed is generally managed effectively in Swansea?

Mean (Average)	3.823
Median	4
Range	9
Mode	5, appeared 30 times
Geometric Mean	0
Largest	9
Smallest	0
Sum	325
Count	85

In the semi-structured interviews, four interviewees rated the management as effective with two unsure or not being able to provide a direct response. Two specialist's and two volunteers both rated the management as effective. The common responses in this category were:

Table 23: Common responses to theme 6.

Topic	Number of responses
• It is effective when managed correctly	III
• Control mechanisms for knotweed	II
• Large areas are left untreated in Swansea	II
• The council lacks manpower or funding	III

The most frequent answer in the online questionnaire was 5 which indicates a tendency for respondents to be neutral. This agreed with the findings in the literature that respondents tend to select neutral values (Boynton & Greenhalgh, 2004).

In order to understand how respondents perceived the primary factor of intuitional, governance and policy context a correlation was made between two questions in the perceived sub-factor of policy and governance strategy and the primary factor of landscape context. The below questions were used for this correlation:

- Question 27: How many years has knotweed been managed in Swansea?
- Question 29: To what extent do you think that knotweed is generally managed effectively in Swansea?

The effectiveness of management was subdivided into three categories low effectiveness (scores 0-3), medium effectiveness (4-7) and high effectiveness (8-10). Using Fischer's exact test, the number of years knotweed has been managed in Swansea was compared with the perceived effectiveness of management. There was no statistical significance found between row and column variables:

Table 24: Years managed and effectiveness of management.

Years managed	Agreement that knotweed is managed effectively						Total	
	Low		Medium		High			
	Number	%	number	%	number	%	number	%
0-9	0	0.0	0	0.0	0	0.0	0	0.0
10-19	6	18.2	9	17.6	0	0.0	15	17.6
20-29	14	42.4	14	27.5	1	100.0	29	34.1
30-39	10	30.3	13	25.5	0	0.0	23	27.1
40-49	0	0.0	8	15.7	0	0.0	8	9.4
50-59	1	3.0	4	7.8	0	0.0	5	5.9
60-69	2	6.1	2	3.9	0	0.0	4	4.7
70-79	0	0.0	0	0.0	0	0.0	0	0.0
80-89	0	0.0	0	0.0	0	0.0	0	0.0
90-99	0	0.0	0	0.0	0	0.0	0	0.0
100+	0	0.0	1	2.0	0	0.0	1	1.2
Total	33	100	51	100.0	1	100	85	100

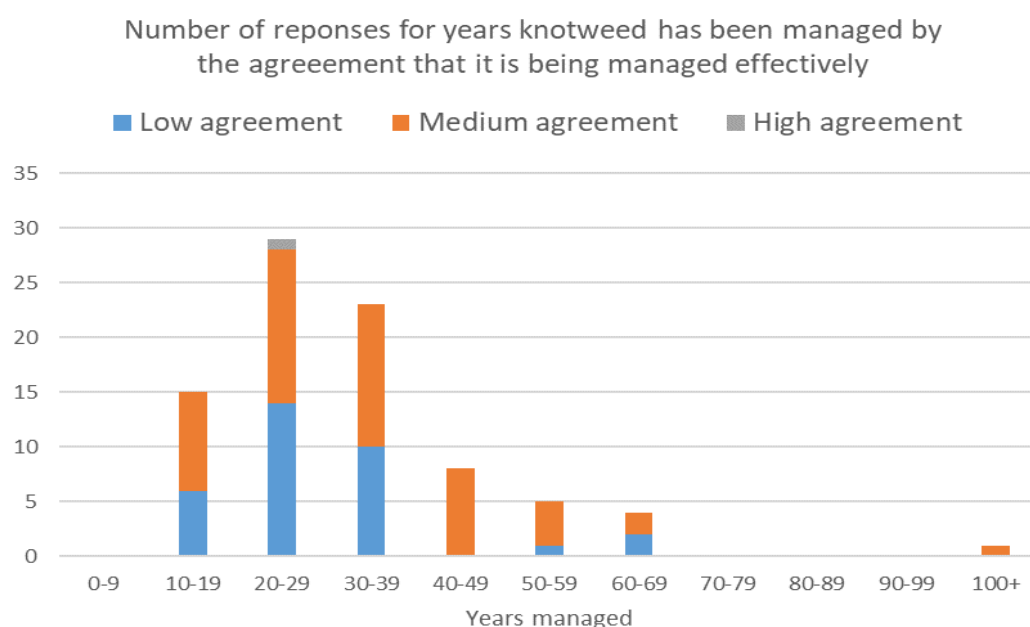


Figure 22: Number of responses for years knotweed has been managed by the agreement that it is being managed effectively.

From comparing the number of responses, volunteers who thought knotweed had been managed for longer rated the management as less effective and volunteers who thought knotweed had been managed for a shorter amount of time rated the management as more effective. The results suggested that there was a greater perceived effectiveness of management over shorter periods of time.

Another correlation was made between the sub-factors institutional frameworks and policy and governance strategy. The below questions were used for this correlation:

- Question 26: Who is responsible for managing knotweed in Swansea?
- Question 29: To what extent do you think that knotweed is generally managed effectively in Swansea?

The effectiveness of management was subdivided into the same three categories low effectiveness (scores 0-3), medium effectiveness (4-7) and high effectiveness (8-10). Using Fischer's exact test responsibility for managing knotweed in Swansea was compared with the perceived effectiveness of management. There was no statistical significance found between row and column variables:

Table 25: Who is responsible for managing knotweed and effectiveness of management?

column %

	Agreement that knotweed is managed effectively							
	Low		Medium		High		Total	
Responsibilities	number	%	number	%	number	%	number	%
Welsh and UK Governme	0	0.0	2	3.9	0	0.0	2	2.4
Landowners	20	60.6	19	37.3	0	0.0	39	45.9
Swansea Council	11	33.3	23	45.1	1	100.0	35	41.2
Don't know	2	6.1	7	13.7	0	0.0	9	10.6
Total	33	100	51	100	1	100	85	100

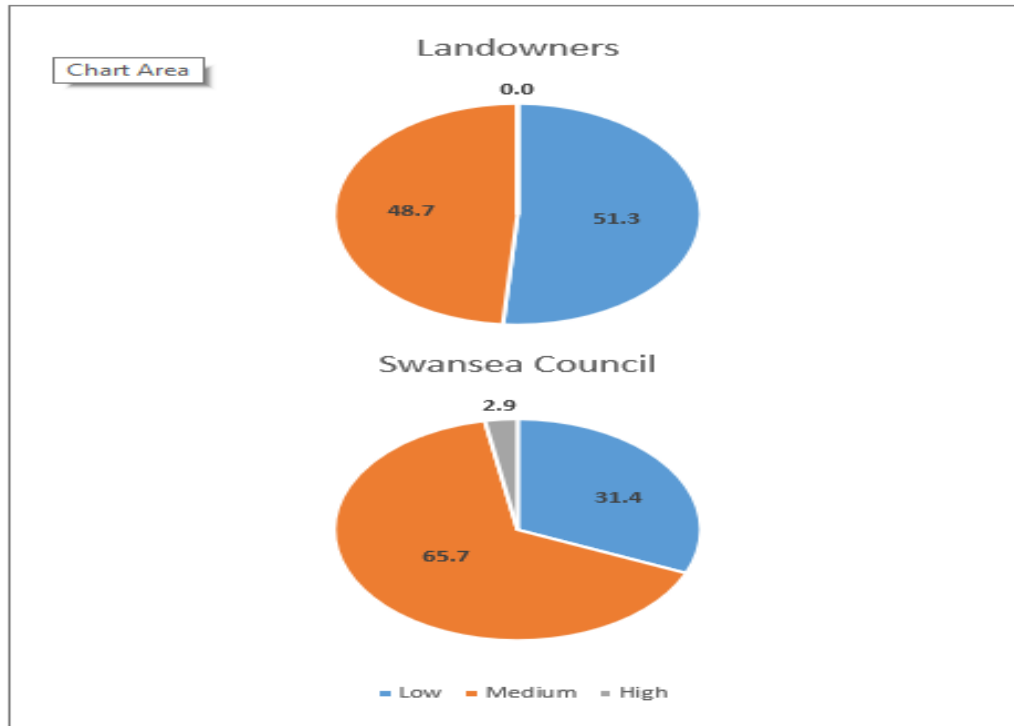


Figure 23: Landowners and Swansea Council management scores.

The results showed 87% of volunteers identified that either the council or local landowners were responsible for managing knotweed in Swansea. This agreed with consensus in the literature that local authorities and landowners are responsible for knotweed (Hathaway, 2000; Gov.uk, 2016). Of those who identified landowners, the respondents scored equally between medium effectiveness (51.3%) and low effectiveness (48.7%). Of those who identified the council, two thirds identified the effectiveness of management as medium indicating a reasonable satisfaction level. The finding suggested that the sampled volunteers are more satisfied with Swansea Council's knotweed management than landowner's management.

The overall results of testing the perceived sub-factors within the institutional, governance and policy context (including institutional frameworks, legislation, regulation and enforcement and policy and governance strategy) **agreed** with consensus within the literature review.

4.2.7: Table 26: A summary of the discussion with the literature review.

6 Key Factors in Influencing Perception	Results were compliant with the literature
1. Individual(s)	✓
2. Species	✓
3. Effects (potential and realised)	✓
4. Socio-cultural contexts	✓
5. Landscape context	✓
6. Intuition, governance and policy contexts	✓

Source: adapted from Shackleton *et al*, 2019

4.3: Summary of research findings

In conclusion, the research established seven findings to the objectives:

Table 27: Findings.

Findings
1. There was a predominantly negative perception of knotweed amongst conservation volunteers in Swansea City
2. Volunteer perceptions of knotweed and perceptions of the management of knotweed mostly complied with the findings of the literature review
3. Regardless of the effective advice provided by the Swansea Council, knotweed was still perceived by volunteers as more damaging than other IAP's
4. The media's portrayal of knotweed had little influence on the conservation volunteers perceptions
5. Volunteers who perceived knotweed as a greater threat, perceived it occupied more land types
6. Volunteers who perceived knotweed had been managed for a shorter amount of time rated its management as more effective
7. Volunteers were more satisfied with Swansea Council's management of knotweed than that of landowners

CHAPTER 5: RECOMMENDATIONS

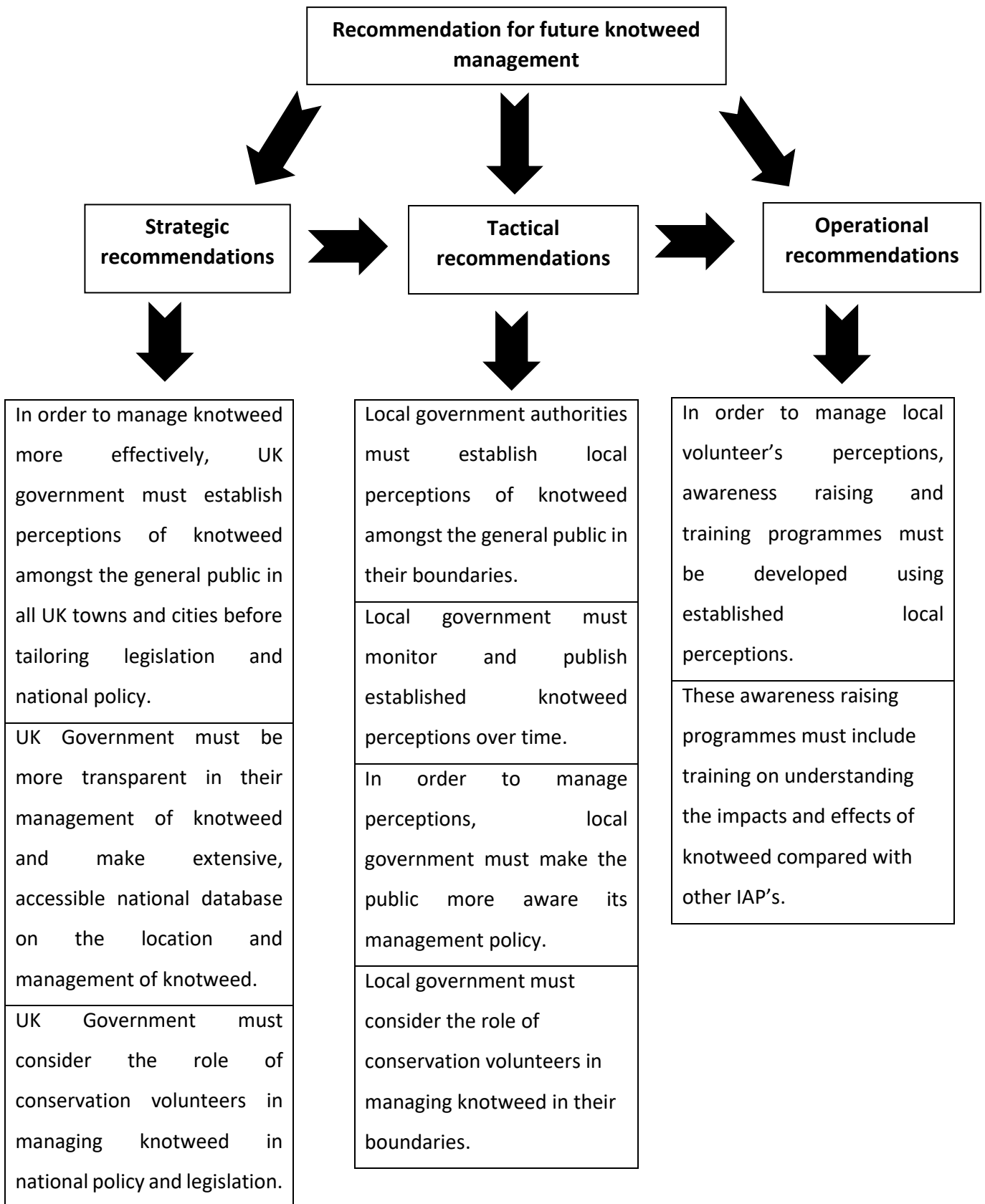


Figure 24: Recommendations flowchart.

5.1: Key players in the strategic, tactical and operational management of knotweed

Based on the findings of the research, the following recommendations were made for knotweed management authorities to use in future knotweed management plans. The recommendations were divided into strategic, tactical and operational categories in order to produce a practical operational plan.

The strategic management recommendations were aimed at UK Government as they produce knotweed policy and guidance and enable legislation.

Tactical management recommendations were aimed at local government and knotweed control specialists. These organisations make local tactical decisions around the management of knotweed and implement local policies.

Operational management recommendations were aimed at environmental organisations, conservation volunteers and members of the public. These operational partners undertake a very important role in the management of knotweed.

CHAPTER 6: CONCLUSION

6.1: Concluding remarks

The research established conservation volunteers' perceptions of knotweed in the City of Swansea.

Shackleton *et al.*, (2019) conceptual framework was applied to the established perceptions and the underlying sub-factors were evaluated to develop the recommendations.

The recommendations were developed from the research findings into a model aimed at strategic, tactical and operational levels for use in future knotweed management plans.

The research's seven main findings were:

- There was a predominantly negative perception of knotweed amongst conservation volunteers in Swansea City
- Volunteer perceptions of knotweed and perceptions of the management of knotweed mostly complied with the findings of the literature review
- Regardless of the effective advice provided by the Swansea Council, knotweed was still perceived by volunteers as more damaging than other IAP's
- The media's portrayal of knotweed had little influence on the conservation volunteers perceptions
- Volunteers who perceived knotweed as a greater threat, perceived it occupied more land types
- Volunteers who perceived knotweed had been managed for a shorter amount of time rated its management as more effective
- Volunteers were more satisfied with Swansea Council's management of knotweed than that of landowners

From undertaking the research the author made three observations:

1. It was challenging to find large numbers of respondents for a statistically significant sample size for the online questionnaire

2. Some volunteers needed additional support with the online questionnaire because they had low levels of literacy and were not computer literate
3. It was challenging to find knotweed specialists willing to give their time for the semi-structured interviews

The limitations of the research were:

- The research examined conservation volunteer's perceptions and did not establish perceptions amongst the general public
- The identified perceptions only apply to the geographical area of Swansea City and can only be used as a proxy for other areas of Wales and beyond
- The identified perceptions are a 'snapshot' at a single point in time and not a longitudinal study
- Due to time constraints, only a selection of the sub-factors identified by Shackleton *et al.*, (2019) that influence perceptions were evaluated

Further research could be focused on rural areas of Swansea for comparison and could also examine other IAPS. Perceptions could be established in other geographical areas and other populations using a similar methodology. As perceptions change over time, this subject area would be an interesting and informative longitudinal study. More research is also needed into the role of conservation volunteers in the long-term management of IAP's.

The research contributed to scientific knowledge by:

- By undertaking correlations from the results, five new insights into volunteer's perceptions were identified that were not present in the published literature
- The new insights contribute to the more effective management of knotweed and to the broader discussion of perceptions of IAPS within the scientific community

IAPS are an important global issue, negatively affecting natural environments and human societies. The research has identified some of the underlying perceptions in conservation volunteers within the City of Swansea. The findings contribute to the broader discussion of the role of perception in managing IAS.

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APPENDICES

Appendix A: Pilot study results

A pilot survey was carried out using Microsoft Forms. The purpose of the pilot questionnaire was to test and identify trends in the data and also identify any difficulties in responder understanding and the results to inform the final questionnaire.

The pilot had 11 respondents and took an average of 15.36 minutes to complete. The pilot was comprised of three sections:

- Socio-demographic information
- Perceptions of knotweed
- Management of knotweed

The pilot questionnaire comprised of 30 questions and respondents could answer in any order.

A. Socio demographic information

Questions 1 to 6 of the questionnaire were aimed at determining socio-demographic traits amongst respondents.

What worked well?

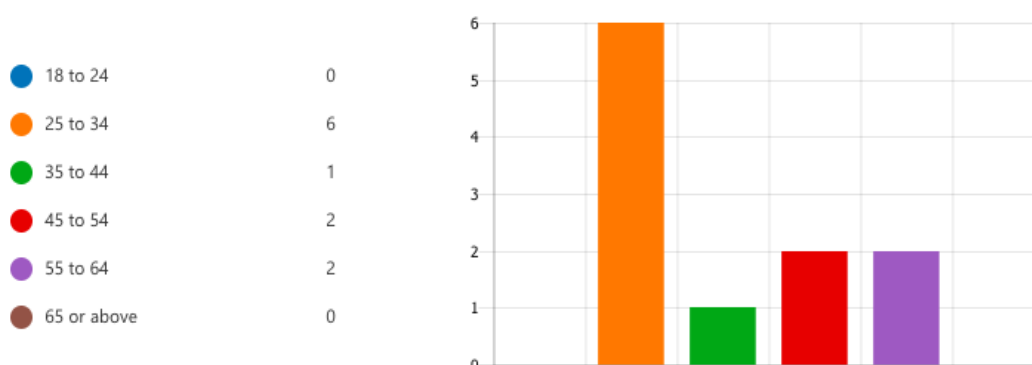
Question 2:

Respondents were categorised into age groups. The most frequent age group was 25 -34 with 6 respondents. However, it is expected that in the final questionnaire that respondents will be generally older with the most likely age group to volunteer being 65 to 74 (NCVO, 2019).

Figure 1.

2. What is your age group?

[More Details](#)



Question 3:

Of 11 responses to question 3 - 5 were Male (45%) and 6 were Female (55%). This distribution generally aligns with gender ratio's worldwide.

Question 5:

Respondents were asked to describe their occupation. All participants answered this question and a broad range of occupation were present including a knotweed specialist.

What needs improvement?

Question 1:

Respondents of the questionnaire were asked which organisation they volunteered with, for the purposes of the pilot it was not mandatory that respondents have to volunteer in Swansea. Four of respondents (44%) volunteered with the National Trust and seven respondents (77%) volunteered with another organisation or not at all. Based on the results of the pilot amendment will be made to the list of voluntary organisations.

Question 4:

Respondents were asked to select their ethnic group with ten respondents describing their ethnicity as white or from a white background and one respondent not wishing

to disclose. It is expected that the final questionnaire results will reflect the general population characteristics in Swansea (Swansea.gov, 2019).

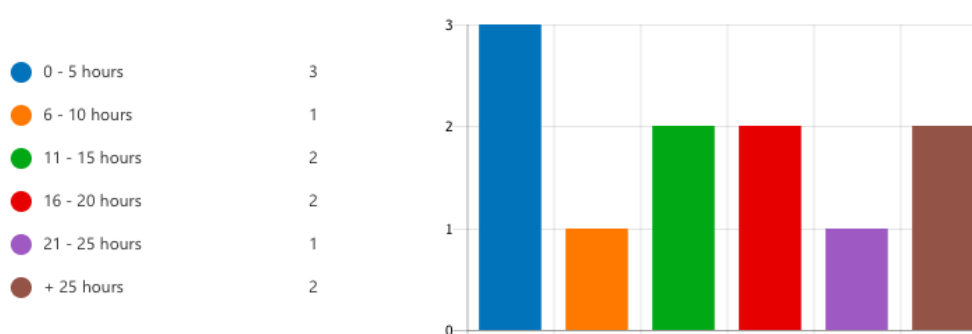
Question 6:

The respondents were asked to estimate the amount of time they spent outdoors per week. The responses to this question are not evenly distributed with no clear correlations. The question shall be rephrased to 'how many hours to you spend in the natural environment per week' for the final questionnaire.

Figure 2.

6. On average how many hours do you spend outdoors per week? (including any volunteering activities)

[More Details](#)



B. Perceptions of knotweed

Questions 7 to 24 of the questionnaire were aimed at determining respondent's perception(s) of knotweed.

What worked well?

Question 8:

Respondents were asked to describe their level of knowledge of knotweed. Of 11 respondents only 2 (18%) were specialist's, 5 (45%) had some or little knowledge and 4 (36%) had no knowledge. The pilot cannot be considered a representative sample as many of the respondents didn't volunteer and the sample group included a knotweed specialist and Environmental MSc students.

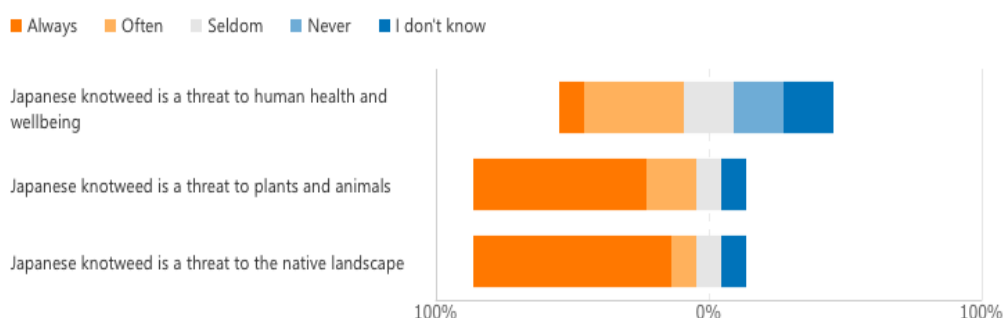
Question 9:

Respondents were asked to assess the threat from knotweed to human health and wellbeing, plants or animals and to the native landscape shown in *figure 3*. Only 9% of respondents felt that knotweed was always a threat to human health and wellbeing whilst 18% thought it was never a threat. In contrast 63% of respondents though knotweed was a threat to plants and animals and 72% though it was a threat to the native landscape.

Figure 3.

9. Choose the best option to describe the following statements. (please mark the box of your preference always, often, seldom, never, I don't know)

[More Details](#)



Questions 10 and 12:

Respondents responded correctly to general knowledge questions such as 'why was knotweed first introduced in the UK?' and 'how long does a knotweed plant live for'; With a majority (55%) knowing that knotweed was introduced as an ornamental plant, and all knowing that knotweed is a perennial plant.

Question 16:

Respondents were asked what types of land were affected by knotweed in a multiple-choice. Of 74 responses 28 (37%) were in more natural habitats such as woodlands and heathlands. 46 (63%) of responses were in human dominated landscapes such as on transport corridors and in domestic gardens.

Question 22:

Respondents were asked to what extent that knotweed impacts on their life with 0 being not at all and 10 having a major impact. A Mean, Median and Range calculation was done on the responses and this found that the medium and mode of the data was 2 indicating a low level of impact.

Table 1. Mean, medium and range

Mean (Average)	3.5454545454545
Median	2
Range	10
Mode	2, appeared 3 times
Geometric Mean	0
Largest	10
Smallest	0
Sum	39
Count	11

Sorted Data Set: 0, 1, 1, 2, 2, 2, 4, 5, 6, 6, 10

What needs improvement?

Questions 13 and 18:

Respondents were asked questions with leading remarks e.g. 'knotweed is the UK's fastest growing weed' and 'knotweed is reported in the media to smash through tarmac.'. These leading statements may cause biases by potentially shaping responses (Boynton and Greenhalgh, 2004).

Question 14:

Ecosystem services from IAP's was a key theme from the literature review. The feedback identified that this question caused confusion and a lack of understanding by respondents.

Question 21:

The respondents were asked to rank the negative impacts caused by knotweed from 1 to 5. 4 out of 11 respondents didn't answer this question correctly, which suggests

a lack of understanding by the respondents. In the final questionnaire the format of the question shall be adjusted to a ranking scale.

C. Management of knotweed

Questions 25 to 31 of the questionnaire were aimed at assessing perceptions of the management of knotweed in Swansea.

What worked well?

Question 26:

Respondents were asked to estimate the amount of years that knotweed has been managed in Swansea. According to a paper by Child et al, the first active management of knotweed in Swansea was in 1992 (Child *et al*, 2001). The median answer amongst respondents was 3 with answers 40,30,20 and 10 years appearing twice each.

Table 2. Mean, Medium, Mode and Range

Mean (Average)	30.5454545454545
Median	30
Range	80
Mode	40 appeared 3 times
Geometric Mean	20.9051634174584
Largest	90
Smallest	10
Sum	390
Count	11

Question 29:

Respondents were also asked whether knotweed is generally managed effectively in Swansea with lower scores indicating poor management and higher scores indicating effective management. The respondents were asked to rate the effectiveness of management from 1 to 10. The median and mode of the data were both three in table 2.

Table 3. Mean, Medium, Mode and Range

Mean (Average)	3.5454545454545
Median	3
Range	9
Mode	3 appeared 3 times
Geometric Mean	0
Largest	9
Smallest	0
Sum	39
Count	11

What needs improvement?

Question 25:

Respondents were asked who is responsible for managing knotweed in Swansea. Respondents were given the chance to submit multiple answers and this affected the final dataset. 8 of 17 (47% of answers said that Swansea Council were responsible for knotweed. A single choice option will be present in the final questionnaire.

Question 27:

Respondents were asked if the Council offers effective advice for managing knotweed. 6 out of 11 (54%) respondents answered the 'other' option. The final questionnaire will have the 'other' option removed.

Question 30:

Knowledge of the legislation and policies that govern INNS are one of the six factors that influence perception identified by Shackleton *et al* (2019). Respondents were asked if the Wildlife and Countryside Act (1981) had been applied effectively in Swansea. The Mean answer was 3.45 which indicated poor implementation. The results of the pilot are not expected to be different from the final questionnaire results as only knotweed specialist tend to have high levels of understanding of legislation (Shackleton *et al*, 2019).

Additional questions for the final questionnaire

- *Has your perception of knotweed changed over time?*
- *Do you think the damage, disruption and problems caused by knotweed are worse than other invasive plants such as buddleia or Himalayan Balsam?*

A summary of Adjustments for final questionnaire

A. Socio-demographic information

<i>Question</i>	<i>Adjustment</i>
<i>Q1: Which organisation do you volunteer with in the City and County of Swansea?</i>	<i>Amend the list of volunteering organisations</i>
<i>Q4: Select your ethnic group.</i>	<i>Take out the other option</i>
<i>Q6: On average how many hours do you spend outdoors per week? (including any volunteering activities)</i>	<i>Rephrase to the natural environment</i>

B. Perceptions of knotweed

<i>Question</i>	<i>Adjustment</i>
<i>Q13/18: Japanese knotweed is the UK's fastest growing invasive weed according to the Environment Agency. How quickly do you think Japanese knotweed grows per day in its peak growing season of July?</i> <i>Japanese knotweed is reported in the media to: * Smash through tarmac * Reduce house prices * Overrun gardens. In your opinion to what extent do you think that the media influences your perception(s) of Japanese knotweed?</i>	Remove leading remarks
<i>Q14: To what extent does Japanese knotweed benefit the natural environment?</i>	Remove or rephrase question
<i>Q21: Japanese knotweed is known to negatively impact upon cities by damaging: *Plants *Animals *Human societies *Transport networks *Devaluing house prices Place these impacts in order of importance to you, with 1 being the most important and 5 being the least important.</i>	Adjust to ranking scale

c. Management of knotweed

<i>Question</i>	<i>Adjustment</i>
Q25: Who is responsible for managing Japanese knotweed in Swansea?	Remove multiple choice
Q27: To what extent do you agree that Swansea Council offers effective advice for managing knotweed?	Remove 'other'
Q30: Under the UK Wildlife and Countryside Act (1981) it is 'illegal to cause Japanese knotweed to grow in the wild'. In your opinion to what extent do you agree that the current legislation is applied effectively in Swansea?	Remove or rephrase question

Appendix B: The final online questionnaire

1. Which organisation do you volunteer with in the City and County of Swansea?
2. What is your age group?
3. How would you describe your gender?
4. Please select your ethnic group.
5. Describe your main occupation?
6. On average how many hours do you spend in the natural environment per week? (including any volunteering activities)
7. How proud are you to volunteer in Swansea?
8. How would you describe your level of knowledge of Japanese knotweed?
9. How big a threat is Japanese knotweed to human health and wellbeing/ plants and animals/ native landscape
10. Why was Japanese knotweed first introduced to the United Kingdom?
11. Estimate the year that Japanese knotweed was first introduced into the United Kingdom?
12. How long does a Japanese knotweed plant live for?
13. How quickly do you think Japanese knotweed grows per day in it's peak growing season of July?
14. how much of a threat is Japanese knotweed to Swansea's natural beauty?
15. What types of land are affected by Japanese knotweed in Swansea?
16. A survey in 1998 by Swansea Council found that 26% of Swansea was covered by Japanese knotweed. What is your estimation for the current coverage?
17. To what extent do you think that the media influences your perception of Japanese knotweed?
18. Would you or have you considered buying a property with Japanese knotweed on the premises?
19. If yes/maybe, please say why you would consider buying a property with Japanese knotweed?
20. Japanese knotweed is known to negatively impact upon cities by damaging:
 - *Plants
 - *Animals
 - *Human societies
 - *Transport networks
 - *Devaluing house pricesPlace these impacts in order of importance.
21. Do you think the damage, disruption and problems caused by Japanese knotweed are worse than other invasive plants such as Buddleia or Himalayan Balsam?
22. In your opinion to what extent does Japanese knotweed impact upon your life?
23. Do you have any childhood memories of Japanese knotweed?
24. If yes/maybe, please describe your memory.
25. Has your perception of Japanese knotweed changed over time?
26. Who is responsible for managing Japanese knotweed in Swansea?

27. How many years has Japanese knotweed been managed in Swansea?
28. To what extent does Swansea Council offer effective advice for managing knotweed?
29. To what extent do you agree that Japanese knotweed is generally managed effectively in Swansea?
30. Under the UK Wildlife and Countryside Act (1981) it is 'illegal to cause Japanese knotweed to grow in the wild'. In your opinion to what extent do you agree that the current legislation is applied effectively in Swansea?

Appendix C: Semi-structured interview schedule

1. I will casually greet participants, e.g. hello good afternoon
2. I will briefly explain the progress of my research
3. I will get written or verbal consent. A confidentiality statement shall be verbally communicated before the interview. The statement will be as follows:

“I am undertaking this research on behalf of UWTSD for my master’s dissertation and not on behalf of any other agency. I am acting as an independent. Nothing you say today will be quoted with your name. I will be submitting a written dissertation, but no confidential names will be mentioned. Do you have any questions about my pledge of confidentiality”?

I will point out any recording devices and make sure they are working

Warm up questions:

- *How long have you been running the Babell graveyard project? And what got you started on that?*
- *How long have you been volunteering?”*
 - A. *Perceptions of knotweed*

Theme 1: *How much of a threat is Japanese knotweed to Swansea’s natural beauty?*

Prompts: You rated the threat posed by knotweed as X in the questionnaire, what were your reasons behind that?

Theme 2: *To what extent do you think that the media influences your perception(s) of Japanese knotweed?*

Prompts: You said in your questionnaire that the media X influences you/doesn’t. Why do you think the media has this view on knotweed? Do you think this view will change?

Theme 3: *Has your perception of Japanese knotweed changed over time?*

Prompts: You said in your questionnaire that Do you think this will change in the future? What are the reasons behind this?

B. Management of knotweed

Theme 4: Do you think the damage, disruption and problems caused by Japanese knotweed are worse than other invasive plants such as Buddleia or Himalayan Balsam?

Prompts: Does management prioritise knotweed over these other species? You said in the questionnaire What were your reasons behind that decision?

Theme 5: To what extent do you agree that Swansea Council offers effective advice for managing knotweed?

Prompts: You said in the questionnaire that the council Offer effective advice what are your reasons behind this? Do you have personal experience?

Theme 6: To what extent do you agree that Japanese knotweed is generally managed effectively in Swansea?

Prompts: In the questionnaire you gave the management and X rating. What were your reasons behind that? Does the management of knotweed affect you personally?

End of interviews, I will thank volunteers for participating in this interview your effort is greatly appreciated

Appendix D: Specialist and volunteer interviews

Specialists interviews.

Theme:	Interview 1	Interview 2	Interview 3
Perceptions: How much of a threat is knotweed to Swansea's natural beauty?	• Knotweed is spreading rapidly • <i>"It's only when it hits peoples pocket it makes a difference"</i> • People are not concerned with it if its only in natural environments • <i>"landowners are not bothered until they decide to sell"</i> • Its 'terrible' when it's not considered a threat, and this facilitates spread • If it's being managed then the threat is recognised • The spread of the plant is more of a threat than the plant itself	• <i>"You have to take it very seriously"</i> • "It's very invasive/fast growing and very difficult to remove" • There are only small pockets on the Gower • <i>"In Swansea there is a lot more that does need to be done and it can be difficult to remove"</i> • <i>"I haven't dealt with it myself cause you need to have the training to deal with the chemicals"</i>	• Natural beauty is subjective • <i>"I don't think it looks particularly nice as a plant, whilst Balsam and Rhododendron does when it's in flower"</i> • <i>"I don't think it causes a threat to Swansea natural beauty, cause for a lot of people if its green its green"</i> • There is no aesthetic threat unless it's in the winter where you can see rubbish
To what extent do you think the media influences your perception of Knotweed?	• "It's all about people not nature" • The media doesn't consider knotweed in the natural environment • <i>"The hysteria is about the built environment and people's value of houses and infrastructure"</i>	• It is a 'negative plant' which creates negative media • <i>"It affects people's mortgages"</i> • There are negative articles in local newspapers that	• <i>"The media influence to much, it's completely over the top, it's completely underserved"</i> • Only of interest to the media If it's considered a problem

	• The damage to structures isn't as bad as the media makes it out to be • Brought in by humans in urban environments	shape public perceptions • "In the past there was lots of media about it being invasive" • "The media always approaches everything with a scare"	• It doesn't cause many physical problems • It causes many psychological and legal problems • There is a tendency for lenders to misperceive knotweed driven by a 'fear of litigation'
Has your perception of Japanese knotweed changed over time?	• Yes, it changes daily • <i>"I go from one extreme to the other from don't panic it's just a plant to your not doing things properly"</i> • It is dependent on positive interaction with stakeholders e.g. developers	• It has remained the same • <i>"I did a degree in environmental biology and became aware of invasive species... my opinions of it have been the same ever since I did my degree"</i>	• <i>"When you first get involved you go along with the main theme that it destroys everything and it's the day of the Triffids"</i> • Not as bad as other IAP species e.g. Buddleia and Bamboo
Management: Do you think the damage, disruption and problems caused by knotweed are worse than other invasive plants such as Buddleia or Himalayan Balsam?	• "Each plant in the wrong place can be devastating" • The effects of knotweed as dependant on location • Recently Wade and Bacon estimated that rhizome would penetrate up to 4m with the majority of rhizomes in the first meter • Rhizome penetration is dependent on soil type/geology	• Each IAP species has its own associated problems so it is difficult to compare impacts • Knotweed has two main impacts its invasiveness and its effects on native species • INNS species on reserve are dealt with via a hierarchy • <i>"I have a problem here with Holm"</i>	• "No, I don't think so although it spreads a lot" • <i>"You do get a big monoculture with it, but you get that with Balsam and lots of other plants e.g. holm oak/ rhododendron/ Laurel"</i> • If untreated on properties it could cause a problem • If its treated then it shouldn't cause any problems

	Excavation of the rhizomes is difficult 'How on earth do you know you have got rid of every single bit'	<i>oak and if I had knotweed I would go for the knotweed first"</i>	
To what extent do you agree that Swansea Council offers effective advice for managing knotweed?	- Not sure/never asked them <i>"You need treatment and monitoring, if I'm taking over someone else's job and I'm not saying the council, I have seen so much bad practise so when I take on a job it's a living thing, if somebody hasn't treated it correctly it can prolong the treatment period for years and years"</i> <i>"People in Swansea despite knowing there is loads of knotweed. Don't really understand the implications"</i> - A range of organisations e.g. surveyors, mortgage providers, the council should provide people effected by knotweed appropriate advice	- The council has a designated knotweed officer <i>"I'm not sure that all councils have. At least there is somebody that people can turn too"</i> - It is advertised on vehicles e.g. vans - The council lacks resources <i>"If we had more money we could employ more people to tackle the problem"</i>	- The council provide advice via email - Treatment schemes are available through the council <i>"There is lots of advice out there, whether it comes from us or someone else"</i>
To what extent do you agree that knotweed is generally	- It is effective when managed - It is very ineffective when not managed	<i>"I'm not sure about the details"</i>	<i>"Where it is treated correctly it works, because there is so much knotweed in</i>

managed effectively in Swansea?	• <i>“Generally, where it is managed it could be better it should be 10 out of 10, that’s why I put 6”</i>	• The council have been being doing trails with biological control • Biological control could cause further problems with the control species • Chemical control is the most common method	<i>Swansea you probably won’t notice much difference”</i> • Not currently an issue on LNR’s • The council has received funding for management • Certain large areas have been left untreated due to a lack of funding or private ownership
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Volunteer interviews.

Theme:	Interview 4	Interview 5	Interview 6
Perceptions: How much of a threat is knotweed to Swansea's natural beauty?	• Not so much a threat on the Gower due to management by organisations such a National Trust • In Swansea it's a problem, particularly on roads/verges • <i>"In parts of Swansea it is pretty bad, to the point that the council cut it like a hedge"</i> • "I have had personal experience of managing knotweed on land joining near my own property"	• "I don't consider urban Swansea to be the kind of landscape or kind of countryside that I would tend to gravitate towards" • In urban area's it is generally under control in parks • It is not under control in wasteland or in gardens • <i>"It's not my kind of environment where I would have a particular view on it one way or the other in terms of the effects it has on landscape cause it's an urban area"</i>	• <i>"If it's allowed to spread then it does affect native species"</i> • There is not much knotweed on the Gower • The knotweed is centred in urban areas
To what extent do you think the media influences your perception of Knotweed?	• <i>"I read that it can be eaten and cooked"</i> • <i>"The media has no influence on my perception...I have personal experience of managing it. If I hasn't had that experience I might be swayed by what people say of this terrible plant"</i> • There is stigma in the media	• Not perceived to be prevalent in the media • More prevalent in recent years due to the effect's homeowners • <i>"Mortgage companies have cottoned on to the possibilities and gone to one extreme, they don't understand it therefore they</i>	• <i>"The media's portrayal doesn't alter my perception of knotweed"</i> • The media does highlight the fact that it is a problem • Although more people ought to be aware of the problem • The media does overemphasis impacts on

	Affects property sales and mortgages	<i>always go to the extreme</i> - It's distorted in the media - Practical management advice is ignored in the media for 'newsworthy' articles	property including devaluation and refused mortgagees
Has your perception of Japanese knotweed changed over time?	<i>"My personal perception is I feel you can manage it"</i> <i>"I think people panic over knotweed, and it's this awful thripid type plant"</i> <i>"Perhaps it's not the horror that it's perceived to be"</i>	- The perception hasn't changed - Known about knotweed since childhood <i>"The generation that I was a part of, it was very natural for everybody to spend their free time after school just outdoors on the hillside. everybody did it."</i> <i>"My generation was very aware of Japanese knotweed"</i>	<i>"It hasn't changed at all its always been negative"</i> <i>"I had happy childhood memories. It was in the garden and we used to make dens and pea-shooters out of it"</i>
Management: Do you think the damage, disruption and problems caused by knotweed are worse than other invasive plants such as Buddleia or Himalayan Balsam?	"All those invasive plants choke, and nothing will grow around them, they take the goodness out of the soil" <i>"I have a lovely Buddleia plant in my garden, and I am happy to have it there cause of the butterflies that come onto it"</i>	- It is not considered a threat by the ordinary person - The threat is from the effects on infrastructure/roads - Balsam doesn't affect properties to the extent of knotweed <i>"on that basis, it (knotweed) is probably going to</i>	<i>"I think it's effects are on par with Himalayan balsam"</i> - Buddleia is easier to control - Knotweed is more destructive to buildings than other IAPS

	• <i>“With our work here with Rhododendrons with the National Trust, we have cut loads out and you can see that nothing grows where there were Rhododendrons”</i> • I have never managed knotweed with the National Trust	<i>top the list of threats simply because of what’s happened in the last couple of years prior to that people didn’t know about it”</i>	
To what extent do you agree that Swansea Council offers effective advice for managing knotweed?	• <i>“I have no experience in dealing with the council therefore I cannot answer this question”</i>	• Has indirect experience in dealing with council • <i>“I do know they have a knotweed team with a knotweed officer, I don’t know if they still have one?”</i>	• No experience in dealing with the council • <i>“There is a gardener who tends to one of my neighbours’ houses who is registered to control knotweed”</i>
To what extent do you agree that knotweed is generally managed effectively in Swansea?	• <i>“There are areas where it is being professionally managed”</i> • Not too aware of the effectiveness of management • <i>“I know where I used to work I drove past a church yard in Mynydd Fach near Moriston way, there was a load of knotweed there, they eradicated it from the churchyard”</i>	• <i>“There are parts of Swansea where I have driven around where it’s really prevalent”</i> • <i>“They have a knotweed control team, for all I know it would be ten times as worse”</i> • The council lacks the manpower/funding • I Would rate the effectiveness of management as 5/10	• <i>“The amount of knotweed in Swansea is far less than 20 years ago”</i> • 6/10 in terms of effectiveness • No complaints

	• The council lacks the manpower/funding		
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Appendix E: Online questionnaire scorecard

1. Which organisation do you volunteer with in the City and County of Swansea?

- The Environment Centre for Swansea = 1
- Singleton Botanical Gardens/Clyne = 2
- Swansea Community farm = 3
- City Allotments or Gardening Club = 4
- Killay Marsh Nature Reserve = 5
- The National Trust = 6
- Penllergaer Woods = 7
- Down to Earth Project = 8
- Babell Graveyard Project = 9
- Rosehill Quarry Group = 10
- Coeden Fach = 11
- NBGW = 12
- Gower Society = 13
- Friends of White Rock = 14
- Friends of Swansea Vale Nature Reserve = 15
- TSD Environment Society = 16
- Parks Department = 17
- I am a woodland owner and member of swog = 19
- Godrergraig park = 20
- Observer = 21
- Swansea Ramblers = 22
- RSPB = 23
- Swansea Council = 24
- None = 0

2. What is your age group?

- 18 to 24 = 1
- 25 to 34 = 2
- 35 to 44 = 3
- 45 to 54 = 4
- 55 to 64 = 5
- 65 or above = 6

3. How would you describe your gender?

- Male = 1
- Female = 2
- Prefer not to say = 3
- Non-Binary = 4

4. Please select your ethnic group.

- White = 1
- Mixed/ multiple ethnic groups = 2
- Asian/Asian British = 3
- Black/African/Caribbean/Black British = 4
- Other ethnic group = 5
- Prefer not to disclose = 6

5. Describe your main occupation?

- Retired = 1
- Student = 2
- Employed (private or public sector) = 3
- Conservation volunteer = 4
- Employed (environmental sector) = 5

6. On average how many hours do you spend in the natural environment per week? (including any volunteering activities)

- 0 - 5 hours = 1
- 6 - 10 hours = 2
- 11 - 15 hours = 3
- 16 - 20 hours = 4
- 21 - 25 hours = 5
- + 25 hours = 6

7. How proud are you to volunteer in Swansea?

- Scaled 0 (Not proud at all) to 10 (Extremely proud)

8. How would you describe your level of knowledge of Japanese knotweed?

- I have little or no knowledge of/experience with knotweed = 1
- I have some knowledge/experience with knotweed = 2
- I am a specialist = 3

9. How big a threat is Japanese knotweed to?

- (1) human health and wellbeing
- (2) plants and animals
- (3) native landscape

- I don't know = 1
- Never = 2
- Seldom = 3
- Often = 4
- Always = 5

10. Why was Japanese knotweed first introduced to the United Kingdom?

- I don't know = 1
- As a building material = 2
- For medicinal purposes = 3
- As an ornamental plant = 4
- To eat = 5
- For use on the railways = 6
- For weed control = 7

11. Estimate the year that Japanese knotweed was first introduced into the United Kingdom?

- 1700 – 1750 = 1
- 1751 – 1800 = 2
- 1801 – 1850 = 3
- 1851 – 1900 = 4
- 1901 – 1950 = 5
- 1951 – 2000 = 6
- 2000 – present = 7

12. How long does a Japanese knotweed plant live for?

- One year or less (annual) = 1
- Every two years (biennial) = 2
- More than two years (perennial) = 3

13. How quickly do you think Japanese knotweed grows per day in its peak growing season of July?

- 0=0cm 1=3cm 2 = 6cm 3 =9cm 4=12cm 5 =15cm 6 =18cm 7 =21cm 8 =24cm
9=27cm 10=30cm

14. how much of a threat is Japanese knotweed to Swansea's natural beauty?

- Scaled 0 (no threat) to 10 (a major threat)

15. What types of land are affected by Japanese knotweed in Swansea?

- Each category = +1

16. A survey in 1998 by Swansea Council found that 26% of Swansea was covered by Japanese knotweed. What is your estimation for the current coverage?

- 0 = 0% 1 = 10% 2 = 20% etc.

17. To what extent do you think that the media influences your perception of Japanese knotweed?

- I don't know = 1
- Strongly influences me = 2
- Influences me = 3
- Not one way or the other/ no opinion = 4
- Doesn't influence me

18. Would you or have you considered buying a property with Japanese knotweed on the premises?

- No = 1
- Maybe = 2
- Yes = 3

19. If yes/maybe, please say why you would consider buying a property with Japanese knotweed?

Common themes (+1) each

- Treatable/control
- Eradication
- Invasiveness
- Density/extent
- Mortgages
- Property damage

20. Japanese knotweed is known to negatively impact upon cities by damaging:

*Plants

*Animals

*Human societies

*Transport networks

*Devaluing house prices

Place these impacts in order of importance.

- Plants = 1
- Animals = 2
- Human societies = 3
- Transport = 4
- House prices = 5

21. Do you think the damage, disruption and problems caused by Japanese knotweed are worse than other invasive plants such as Buddleia or Himalayan Balsam?

- Yes = 1
- No = 2

22. In your opinion to what extent does Japanese knotweed impact upon your life?

- 0 = not at all 5 = to a medium extent 10 = to a great extent

23. Do you have any childhood memories of Japanese knotweed?

- No = 1
- Maybe = 2
- Yes = 3

24. If yes/maybe, please describe your memory.

Common themes (+1) each

- Playing in knotweed
- Location(s)
- Sally/gypsy rhubarb
- Spread/distribution
- Management/control
- Eating
- Pipes/peashooters/dens/javelins

25. Has your perception of Japanese knotweed changed over time?

- I don't know = 1
- Not at all = 2
- It has remained the same = 3
- Slightly = 4
- Completely = 5

26. Who is responsible for managing Japanese knotweed in Swansea?

- I don't know = 1
- Private companies = 2
- Welsh and UK Governments = 3
- Landowners = 4
- Swansea Council = 5

27. How many years has Japanese knotweed been managed in Swansea?

- 0=0 years 1=10 years 2=20 years 3=30 years 4=40 years 5=50 years 6=60years 7=70years 8=80years 9=90years 10=100 years

28. To what extent does Swansea Council offer effective advice for managing knotweed?

- I don't know = 1
- Bad advice = 2
- Not effective advice = 3
- Neutral or no opinion = 4
- Effective advice = 5
- Very effective advice = 6

29. To what extent do you agree that Japanese knotweed is generally managed effectively in Swansea?

- 0 = not at all 5 = some management but needs improving 10 = the plant is totally controlled

30. Under the UK Wildlife and Countryside Act (1981) it is 'illegal to cause Japanese knotweed to grow in the wild'. In your opinion to what extent do you agree that the current legislation is applied effectively in Swansea?

- 0 = not at all 5 = some implementation but needs improvement 10 = total implementation