State of Palestine

National Invasive Species Strategy and Action Plan

2022-2030

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1. Executive Summary:

Alien species (non-native, non-indigenous, foreign, exotic) refers to a species, subspecies, or lower taxon introduced outside of its natural range (past or present) and dispersal potential, for example, outside the range it occupies naturally or could not occupy without direct or indirect introduction or care by humans, and includes any part, gametes or propagule of such species that might survive and subsequently reproduce (IUCN 2000). Invasive Alien Species (IAS) have the ability to establish themselves quickly in disturbed areas, due to their eco-flexibility and strong ability to compete for existing resources causing negative impacts on biodiversity, human health, agriculture, and infrastructure.

About half a million species are reported as invasive worldwide (Pimental *et al*., 2001). The invasiveness threat increased because of ease of transportation, and human habitat destruction that opens many avenues for invasive species to be established around the world. In fact, these invasive species are now considered the second most important threat to biodiversity, after direct habitat destruction by humans (Kettunen *et al*., 2008).

Since 2015, Palestine ratified the Convention on Biological Diversity (CBD), therefore is committed to the global priorities, guidelines, information collection, and international coordination of IAS. Among these obligations is to set up a national strategy on IAS, develop legislations to prevent the introduction of new IAS and the spread and management of the already present IAS, carry out risk analysis, to make use of information and communication technology for carrying out risk communication, and provide infrastructure.

Various approaches have been used to collect data on IAS including a desktop study, letreture review, and field survey for different taxa including plants, birds, mulasca, and insects. We also investigated the status, pathways, vectors, eradication and control methods, and potential threats imposed by IAS. All collected data form the baseline for the team to prepare the First National Strategy for Mitigating the Threats of IAS in Palestine

2. List of Acronyms:

Acronym	Word
CBD	The Convention on Biological Diversity
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
EQA	Environment Quality Authority
FAO	Food and Agriculture Organization
GISP	Global Invasive Species Program
GRIIS	Global registry of introduced and invasive species
IAS	Invasive alien species
IAPS	Invasive alien plant species
IABS	Invasive alien Bird species
IAIS	Invasive alien Insect species
IUCN	International Union for the Conservation of Nature
NSIAS	National Strategy on Invasive Alien Species.

3. Current situation analysis:

Unfortunately, the current situation of occurrence, status, assessment, and management of IAS in Palestine is not in accordance with the size of threats IAS place on the environment and the socio-economic status. In fact, there is a lack of data regarding IAS in Palestine. The Palestinian Sixth national report submitted to the secretariat of the CBD identifies IAS as one of the main threats facing maintaining biodiversity in the country. Nevertheless, very few studies focus on IAS (e.g., species, distribution), their impacts on the Palestinian environment, health, and socio-economy. The report also states that a comprehensive survey and assessment of the invasive species is urgently needed to develop a national strategy for combating, managing, and eradicating IAS. It is also indicated that there are four invasive alien bird species (IABS) namely; Rose-ringed Parakeet (*Psittacula krameri*), Common Myna (*Acridotheres tristis*) Indian Silverbill (*Lonchura malabarica*) and Monk Parakeet (*Myiopsitta monachus*). In addition to one mammal the Coypu (*Myocaster coypus*). The sixth national report revealed the existence of 48 different invasive alien plant species (IAPS, see table 1) leading to major impacts on endogenous plant communities and socio-economic status. We expect that this number of IAPS represent most of the records from historical Palestine; therefore, the number of IAPS does not represent the actual number in the West Bank and Gaza Strip. The invasive invertebrate species were not documented in the fifth national report, as data was not available. Furthermore, the Global Registry of Introduced and Invasive Species (GRIIS) has only 16 different reported IAS in Palestine of different taxa (table 2). Reported species are summarized in (table 2). On the other hand, only limited studies show the status and distribution of few invasive invertebrate species in Palestine. Nonetheless, four insect species have been reported, namely; *Aedes albopictus* mosquito in Salfit district, *Deroplax silphoides* and *Leptoglossus occidentalis* true bugs, and the Red Palm Weevil, *Rhynchophorus ferrugineus* which is one of the most common invasive insects in the West Bank. For the Mollusca group, three land snails and one freshwater invasive snail species have been recorded; (*Cornu aspersum*, *Cochlicella acuta*, *Rumina decollate*, and *Pseudoplotia scabra*) in Palestine.

In 2019, a book entitled "Checklist and Ecological Database of Wild Plants of the West Bank-Palestine" (Al-Sheikh, B., 2019) was published by the Ministry of agriculture, that included a checklist of all recorded plant species. In the book, there are 16 different invasive plant species, though their distribution, pathways and invasion aggressiveness were not examined or evaluated.

Earlier in December 2020, Al-Najah National University held the "First Conference on Biodiversity in Palestine and the Middle East: Invasive Organisms for the Local Environment". The species discussed in the conference included the Rabbit fish (*Lagocephalus sceleratus*), and the Nomadic jellyfish (*Rhopilema nomadica*) in the Mediterranean, the Asian tiger mosquito (*Aedes Albopictus*), Rose-ringed Parakeet (*Psittacula krameri*), Common Myna (*Acridotheres tristis*), and the highly invasive Ambrosia species (*Ambrosia confertiflora*).

Climate change is expected to exacerbate the impacts of IAS in Palestine, though no studies have been done so far to evaluate its extent. The team is not aware of any other publication, or currently running studies in this regard.

Table 1: IAPS reported in the Sixth National Report

Species	Introduction into Palestine	Origin
Acacia cyclops	1920	Southwestern Australia
Acacia karroo Hayne	1927 - 1930	Southern Africa
Acacia paradoxa DC.	1920	Southeastern Australia
Acacia salicina Lindl.	1920	Eastern Australia
Acacia saligna	1920	Southwestern Australia
Acacia victoriae	1948	Australia
Alianthus altissima	1960	China
Ambrosia confertiflora	1990	Southern USA and Mexico
Atriplex holocarpa	1960	Southern Australia
Azolla filiculoides	Unknown (first found 1980)	South America
Carpobrotus edulis	Unknown	South Africa
Conyza bonariensis	1896	South America
Conyza albida	1957	South America
Conyza canadensis	1939	Canada
Cyperus involucratus	Unknown	East Africa
Cyperus odoratus	1980	Tropical regions
Datura stramonium	1920	Tropical south America
Dodonaea viscosa	Unknown	Australia
Eichhornia crassipes	Unknown	Northern Brazil
Eucalyptus camaldulensis	1890	Australia
Ficus benghalensis	1940	India
Ficus microcarpa	Unknown	India, Sri Lanka, southern China, northern Australia
Ficus religiosa	Unknown	India, Pakistan, Bangladesh
Heterotheca subaxillaris	1975	Eastern US
Ipomoea aquatica	2009	Central China
Lantana camara	Unknown	Tropical central America

Myriophyllum aquaticum	Unknown	South America
Nicotiana glauca	1898	Western South America
Oenothera drummondii	1912	North Carolina
Oxalis pes – caprae	1906	South Africa
Parkinsonia aculeata	1922	Southern US
Paspalum distichum	1939	Southern US to Caribbean Islands and tropical South America
Pennisetum clandestinum	1920	East Africa – (Congo, Tansania, Kenya, Rwanda)
Phytolacca americana	1898	US
Pinus brutia	1927	Northeast Greece, southwest Turkey, Cyprus, Lebanon
Pistia stratiotes	Unknown	South America
Prosopis juliflora	1948	Mexico, northern South America
Ricinus communis	1894	Topical Africa
Robinia pseudoacacia	1922	Southeastern US
Salvinia molesta	1970	Southern Brazil
Schinus molle	1919	Chile, northern Argentina
Schinus terebinthifolius	Unknown	Subtropical Brazil
Sesbania sesban	Unknown	East Africa
Solanum elaeagnifolium	1957	Southwestern US, northeastern Mexico
Verbesina encelioides	1970	Southern US, Mexico
Washingtonia robusta	1905	Southwestern US
Xanthium strumarium	1921	Western US

Table 2: Invasive species reported in GRIIS

No.	Species	Class	Order	Family	Taxon Rank
1	Acridotheres tristis	Chordata	Aves	Passeriformes	Sturnidae
2	Ailanthus altissima	Tracheophyta	Magnoliopsida	Sapindales	Simaroubaceae
3	Ambrosia confertiflora	Tracheophyta	Magnoliopsida	Asterales	Asteraceae
4	Eichhornia crassipes	Tracheophyta	Liliopsida	Commelinales	Pontederiaceae
5	Erigeron bonariensis	Tracheophyta	Magnoliopsida	Asterales	Asteraceae
6	Lonchura malabarica	Chordata	Aves	Passeriformes	Estrildidae
7	Myocastor coypus	Chordata	Mammalia	Rodentia	Myocastoridae
8	Nicotiana glauca	Tracheophyta	Magnoliopsida	Solanales	Solanaceae
9	Oxalis pes-caprae	Tracheophyta	Magnoliopsida	Oxalidales	Oxalidaceae
10	Paratrechina longicornis	Arthropoda	Insecta	Hymenoptera	Formicidae
11	Prosopis juliflora	Tracheophyta	Magnoliopsida	Fabales	Fabaceae
12	Psittacula krameri	Chordata	Aves	Psittaciformes	Psittacidae
13	Ricinus communis L.	Tracheophyta	Magnoliopsida	Malpighiales	Euphorbiaceae
14	Sarcopoterium spinosum	Tracheophyta	Magnoliopsida	Rosales	Rosaceae
15	Setaria verticillata	Tracheophyta	Liliopsida	Poales	Poaceae
16	Solanum elaeagnifolium	Tracheophyta	Magnoliopsida	Solanales	Solanaceae

4. Project's Strategy and Approach:

Our plan for preparing and developing the National Strategy for Mitigating and Managing the Threat of Invasive Alien Species in Palestine, will be based on several international and regional guidelines. Additionally, taking into consideration relevant conventions and treaties, with special focus on the CBD. Article 8(h) of the CBD states that the State of Palestine, as a Contracting Party should, "as far as possible and appropriate, prevent the introduction of, control or eradicate those alien species that threaten ecosystems, habitats or species. The Aichi Target 9 of the CBD emphasizes, "By 2020, invasive alien species and pathways are identified and prioritized, priority species are controlled or eradicated, and measures are in place to manage pathways to prevent their introduction and establishment". Therefore, The Aichi Biodiversity Target 9 aims to halt biodiversity loss by addressing IAS issues as a matter of global priority. Several other legally-binding international agreements and treaties such as the Ramsar Convention, Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), and the International Plant Protection Convention have also acknowledged IAS as an important component in biodiversity conservation and have been encouraging and supporting "Contracting Parties" to take actions to prevent, eradicate, and control IAS. Moreover, other international non-binding agreements, instruments, and guidance such as Food and Agriculture Organization (FAO), and the International Union for the Conservation of Nature (IUCN) have addressed IAS through a variety of economic sectors and cooperates with other international instruments, or provide guidelines for the prevention of biodiversity loss caused by IAS (e.g., Global Invasive Species Program (GISP)), respectively. Therefore, the National Strategy on Invasive Alien Species (NSIAS) will be developed to provide guidance in preventing the introduction and spread of invasive species and to manage their impacts on biodiversity in an effective manner.

Data collection on IAS was approached by several methodologies in order to develop a comprehensive information collection process; including occurrence and distribution, main vectors of spread and pathways for the various species, and an indication of their impacts on biodiversity and socio-economic implications

This study follows the hierarchical approach that incorporates three key elements:

1. Prevention: taking into consideration that prevention of IAS introduction, in general, is more environmentally desirable and cost-effective than measures taken after IAS introduction and establishment.
2. Early detection and eradication: taking into consideration that early detection and rapid action are crucial to prevent IAS establishment.
3. Control and long-term containment and management: according to the CBD Guiding Principle 2, if eradication is not possible or resources are not available, then containment and long-term control measures needs to be implemented.

The following activities was carried out in order to achieve the required outcomes for the second report:

a) **Desktop study:** The team of NPS conducted a comprehensive literature review prior to the survey, including grey literature, on existing information related to IAS at the national and regional level. Collected data and information were analyzed, synthesized, and critically evaluated to give a clear picture of the current state of knowledge on IAS in Palestine. After the survey was completed, the team looked for studies investigating the vectors, pathways, and impact of IAS on biodiversity and socio-economic aspects, focusing on the most problematic species. The desk study regarding this issue covered materials at the international and regional level, and special focus was given to neighboring countries.

b) **Baseline survey:** fieldwork and surveys to collect data and information on IAS of different taxa that included plants, birds, mammals, reptiles, and to lesser extent invertebrates took place. The focus of the survey was on specific sites that are known to hold high population density of the most problematic IAS, which were evaluated during the desk study and field survey. The survey for each group of taxa was conducted according to systematic methodology that provided a comprehensive data on the occurrence, distribution, establishment stage, vectors, and pathways of investigated species. The fieldwork and survey conducted, during species peak periods, as possible, which varies from one taxon to another. For example, survey and fieldwork of annual invasive plant species was conducted during the growth peak and flowering period. For birds, mammals, and reptiles, the survey and fieldwork were conducted during breeding season (during mating and rearing offspring) while the animals are in their peak of activities. During the fieldwork, special tools and equipment were used depending on the species in investigation. In addition, a special open-source platform (KoboCollect) was used to collectet field data (e.g., location, species).

   Plant taxonomic survey: an experienced Plant taxonomist conducted 15 days of field survey, between April and June to identify existing invasive alien plant species, investigated their occurrence and distribution, ways of spreading (vectors) and pathways and evaluated their possible impacts on biodiversity, focusing on the most problematic species.

   Vertebrate (birds, mammals, and reptiles) survey: the lead ecologist and ornithologist of the project conducted the field survey in a total of 15 days of fieldwork. The survey was conducted during 2021, but majority of the work was between April and July, where the animals are in their peak of activities. Collected data included identifying existing invasive alien animal species, their occurrence and distribution, ways of spreading and pathways, when possible, and examined their possible impacts on biodiversity, focusing on the most problematic species.

   Invertebrate survey: an experienced entomologist conducted the survey and fieldwork for 15 days, between April and July of 2021, where the insects, and other invertebrates

(e.g., snails) are at their peak of activities (e.g., production and growth). The entomologist focused his efforts on the main invasive alien invertebrate species, documented their occurrence, distribution, and investigated ways of spreading and pathways, when possible, and examined their possible impacts on biodiversity, focusing on the most problematic species.

All collected data was sorted, evaluated, and analyzed, to support building the Palestinian Invasive Alien Species Database. This step is very essential and important in order to build and develop the National Strategy for Mitigating and Managing the Threat of Invasive Alien Species.

5. Fauna

5.1 Vertebrate

5.1.1 Birds

Recent studies suggest that 551 bird species have been recorded in the region of historical Palestine (Meiri et al. 2019) of which 375 are in Palestine (West Bank and Gazza). A total of twenty-five species of birds are documented as introduced species in historical Palestine, seven species of them did not succeed to reproduce in the wild, while the remaining 18 species have established populations in nature and urban areas (Roll et al., 2008). According to Williamson (1996), the introduced bird species can be divided into 3 main categories:

a) Non-indigenous birds established locally and definitely reproducing in nature including *Alopochen aegypticus, Amandava amandava, Anas bahamensis, Cercotrichas podobe, Corvus splendes, Lamprotornis sp., Lamprotornis superbus, Myiopsitta monachus, Nandayus nenday, Oena capensis, Ploceus velatus, Psittacula eupatria, Sturnus burmannicus, Sturnus nigricollus*.

b) Non-indigenous birds are currently increasing in number and spreading to new localities. (*Acridotheres tristis, Psittacula krameri*).

c) Non-indigenous birds established in a widespread area but no longer significantly increasing numbers or range. (*Euodice malabarica, Streptopelia sennegalensis*).

Roll et al. (2008) documented 25 species of invasive birds at historical Palestine, but Meiri et al. (2019) minimized the number to nine, where *Oena capensis* was excluded, six species were confirmed as invasive species, while the last two species are considered as native species, since they were introduced decades ago. The Namaqua Dove **(***Oena capensis*) and Palm Dove **(***Streptopelia sennegalensis*) are not considered as invasive species.

5.1.1.1 *Psittacula krameri* (Rose-ringed parakeet)

Family: Psittacidae

The rose-ringed parakeet is is a medium-sized parrot, native to central Africa and south Asia. It was introduced to many other countries worldwide, including Palestine. (BirdLife International, 2012; Bulter, 2005; Strubbe and Matthysen, 2007; Shirihi, 1996, Voous, 1985). The rose-ringed parakeets are cavity nesters, largely social species, and gathers in good numbers at roosting sites (night and day) and during foraging. Breeding pairs are recorded in singles or small groups, even sometimes on the same tree or in nesting-holes on the same building. The peak of aggregation at night roost of this species is documented to occur during the non-breeding season (between September and January). The diet of the Rose-ringed parakeet is mainly dry and fleshy fruits and seeds, to lesser extent vegetables, flowers, and sometimes nectar.

Pathway: In historical Palestine, 6 pairs of rose-ringed parakeet were brought from Iran in 1962-63 and escaped in Herzliyya area. Thereafter, during 1970s, the species was imported as a cagebird. Other small captive populations escaped from zoos in Tel-Aviv area. The first breeding recorded of the species was documented in 1983, at Miqwe Yisreal. During the following years, the breeding of the rose-ringed parakeet was recorded annually.

Local distribution: Until mid.1990, the species was recorded breeding and foraging only in the Jordan valley (Jericho: 30 individuals, February 1985) and Gaza Strip (20 individuals, Nov 1988). Recently, the rose-ringed Parakeet has been recorded all over the West Bank and Gaza Strip, with higher densities in low-lying areas but in the form of patches. It is recorded in all climatic regions (map 1) near or within urban areas, or cultivated areas with medium to tall trees and different types of orchards.

Potential threats: Invasive avian species were indicated for negative economical, ecological, and health effects. The Rose-ringed parakeet was ranked as one of highest among bird species (Kumschick and Nentwig 2010). The bird is classified as an agricultural pest in several countries (e.g, Koopman and Pitt 2007; Paton et al. 1982), posing severe negative impact on

different cereal crops (e.g., corn, sunflower) and fruit crops. The species is well documented to compete with other birds and small animals on food resources and nesting sites (cavity nesting birds and other animals such hoopoe and Syrian woodpecker), and the dispersal of invasive plant seeds. The Rose-ringed parakeet is a known reservoir and vector for several human, wildlife, and even livestock diseases (Altizer et al. 2003; Fèvre et al. 2006; Lever 2005; Pimentel et al. 2000; Weber 1979), specially, at urban roosting and foraging sites. Some of these pathogens and parasites include viroses; Adenovirus-like viruses, Circovirus, Avihepadnavirus, respiratory herpesvirus, Avian Influenza A/H9N2, Papillomavirus, Paramyxovirus, Polyomavirus, and Reovirus, bacteria; *Chlamydia spp., Streptococcus spp., and Enteroccocus spp*, protozoans; include *Cryptosporidium spp., Eimeria sp., Haematoproteus sp., Plasmodium (N.) dissanaikei,* and *Sarcocystis sp*, fungi; include *Cryptococcus neoformans and Saccharomycetales* (Pisanu et al. 2018, Klug et al. 2019).

Eradication and Control: The rose-ringed parakeet is a widespread invasive species in many countries around the globe; therefore, several eradication and control methods were examined, such as chemical controls, wetting agents, lethal shooting, capture devices (trapping & nets), and fertility control (conraceptive, egg destruction, nest destruction).

5.1.1.2 *Acridotheres tristis* (Common myna)

Family: Sturnidae

The Common myna is native to southcentral and southeastern Asia, where its breeding range extend from Afghanistan through India and Sri Lanka to Bangladesh (Feare & Craig 1998). The bird was introduced and subsequently became invasive in many countries and islands of all continents except Antarctica (Cohen et al., 2019). The common myna is a territorial bird and a highly commensal species, and lives in close associations with humans. The bird has been intentionally introduced to several countries and islands with warm temperate to tropical climates to control invertebrate pests (Case 1996, Veltman et al. 1996, Feare & Craig 1998). In many parts of the world, the common myna, and other myna species, are considered as a pet species (cage birds), and in many cases the bird either escaped or was released into the wild. The species is an omnivorous scavenger (generalist) and can adapt easily to different climates

and habitats (Feare and Craig, 1999). It feeds on fruits, grains, flowers, nectar, invertebrate, birds' eggs and chicks, and small reptiles. (Markula Hannan-Jones & Csurhes 2009, Peacock van Renburg & Robertson 2007, Feare & Craig 1998). The common myna inhabits a wide range of habitats including woodland, cultivated areas, grasslands, and even desert oasis. However, the highest densities of the common myna is found to be in human modified habitats including, urban areas, farmlands, rural areas, parks, gardens, and roadsides (Gill 1999; Heather & Robertson 2000). The breeding season of the Common myna in our region is between April and August, but it might vary depending on habitat conditions, often associated with human activities.

Pathway: In historical Palestine, the bird was first recorded in Eilat, during1987. This single record was the only one until 1997, when small groups were found in Park Hayarkon, Tel Aviv Area. The species escaped or was intentionally released from a privately owned bird facility of exotic species in Tel Aviv public park (Sapir, 2003). Thereafter, the population of the common myna increased rapidly in numbers and distribution. The first confirmed nest was located in the same area in 2000. In Palestine, the first records of the common Myna bird were during 2005-2006 in Qalqilia and Tulkarem and Jenin area, however, the common myna was overlooked in the West Bank, and Gaza strip as a result of lack of research and birdwatching activities. Most probably, the Common myna expanded its distribution and number from historical Palestine to reach the West Bank and Gaza Strip.

Local distribution: Until 2006, the common myna was recorded in west northern parts of the West Bank, and some localities within the western southern parts of the Dead Sea. Since then, the common myna expanded its population dramatically in numbers and distribution to cover all human disturbed habitats including urban and built-up areas, cultivated areas, farmlands, rural areas, parks, gardens, roadsides and dumping areas. It has been recorded to breed in manmade infrastructure, and nesting sites of atother animals including different types of holes (e.g., drainpipes) and crevices in buildings, trees, electrical pools (Stoner 1923).

Potential threats: The common myna is a social and commensal bird that gathers in flocks during roosting and foraging time. They are also a very vocal bird species all year round, therefore, considered as a public nuisance. In addition, and since they roost and forage in large groups, their droppings are also considered nuisance and negatively affect the public health. Since Common myna is an omnivore bird species, they are known to feed and damage on agriculture crops, such as fruit crops (e.g., grapes, apricot, pears, apples, strawberry, and figs (Heather and Robertson 1997), and steal food off plates from outdoor restaurants or during outdoor festivals, and scavenge food from people's houses and gardens. All these issues pose human health risk associated with the Common myna. In addition, the bird is known to carry bird mites (e.g., Ornithonyssus bursa and Dermanyssus gallinae) that might infect humans. The dropping of the common myna might spread Psittacosis, Ornithosis, Salmonellosis and arboviruses They may also carry owl flies, biting lice, Oxyspirrura thread worm and round worm (Stoner 1923), and carry avian malaria (Massam 2001) as well. The Common Myna recorded preying on other birds' eggs and chicks, competing with other small birds and mammals for nesting sites and hollows, and foraging areas. Therefore, many studies indicated

significant decline of endogenous bird species and other small mammals. A recent study about the effect of invasive bird species on native common bird species in Israel showed that the population of four common native bird species declined significantly (Colléony and Shwartz, 2020), including the house sparrow (declined by 28%), Spectacled bulbul (declined by 48%), Eurasian hoopoe, and blackbird.

Eradication and control: Common Myna are classified by many countries in the highest threat categories of invasive bird species (Markula et al 2009, Bomford 2003), therefore, several eradication and control methods were developed and used, including physical (e.g., foraging traps, nesting traps, lethal shooting), and chemicals (toxins, wetting agents, fertility control, and egg destruction).

5.1.1.3 *Myiopsitta monachus* (Monk parakeet)

Family: Psittacidae

The natural distribution of the Monk Parakeet is extending from Subtropical and temperate South America, including Bolivia, Paraguay, Uruguay, southern Brazil south to the Patagonia region of Argentina (Campbell, 2000). The species was introduced to many countries worldwide (e.g., Eastern United States, southern Canada, and several countries in Europe, Asia, and the Middle East). The Monk Parakeet usually is found in loose flocks of 15-20 birds, and in some cases can reach 100 birds. This bird is relatively vocal with a wide type of screeching, squawks and chattering. The bird inhabits open habitats, ranging from savannah woodlands, farmlands, plantations, orchards, and cultivated forests. This species of parakeet is the only one that builds its own nest, which allows them to adapt to colder environments and urban areas in their invaded regions. Within its native range, the monk parakeet is considered as an agricultural pest, as it causes severe damages to field crops and orchards. In addition, since this parakeet builds its own nest (communal stick nesters); they are reported to cause transmission lines short-circuited by nesting birds and damage human infrastructure. In their native range, Monk parakeet are generalist granivores, feeds on maize, millet, sorghum, sunflowers and other seeds. They are also recorded feeding on fruits, nuts, berries and insects, but they are flexible in their diet (Pruett-Jones et al, 2007). The Monk parakeet is a CITES-listed species -Appendix ii (BirdLife International).

Pathways: The Monk parakeet became a popular pet bird in the mid-1900. It was first observed in Tel-Aviv district back in the 1995, but the first record of breeding birds was in 1998, in the same area. Although the initial population size in Tel-Aviv area is not known, but four monk parakeets were released in the mid-1990 (Postigo et al., 2017). The Monk parakeet population size in historical Palestine is estimated to be between 1162-1943 in 2015, while the number of chambers reached 1213 (2.37± 2.24 chamber per nest). The nesting sites were found to be divided between urban habitat (92 nest), agricultural habitat (326 nest), and semi-agricultural habitat (93); therefore, the majority of nests were found in agricultural and semi-agricultural habitats. The nests were located at five different types of trees, namely; Aleppo pines *Pinus halepensis* (65.9%), Date palms *Phoenix spp*. (16.8%), Eucalyptus spp. (10.8%), Canary pines *Pinus canariensis* (4.3%), and Fan palms, *Washingtonia spp*. (2.0%).

Local distribution: The Monk parakeet has been recorded in the West Bank in all climatic regions, within urban areas and agricultural fields. It was recorded building nests on several type of trees including *Washingtonia spp, Phoenix spp, and* Eucalyptus spp, in Jenin, Nablus, Tubas and Jericho districts including the Jordan vally.

Potential threats: The population growth rate of the Monk parakeet in historical Palestine is increasing exponentially, three times higher than the reported rate in the United State. This is a very serious issue, as future population and range increase is expected to be very significant. The Monk parakeet, in its native distribution range, is considered as an agricultural pest, causing damage to field crops, orchards, and other agricultural plantations. It is documented to cause damage to human infrastructure, especially in its invaded areas (e.g., electrical substations, transmission lines, distribution lines, pylons, communication towers), as this species of parakeet nests in colonies, building a single, large bulky nests that have separate entrances (chambers) for each pair of birds. In addition, the Monk parakeet might transmit plant diseases, by transporting infected planting materials to uninfected trees, such as citrus cancer, which is a major concern, for example in Florida (Newman et al, 2004). Researchers suggested that monk parakeet might spread Newcastle disease (Fitzwater, 1988).

Eradication and Control: Since the Monk parakeet are very popular in the pet trade business, and known for their beauty and intelligence, they became a widespread invasive species in many countries worldwide. Several eradication methods have been used in several countries including lethal shooting, traping (cage traps and whoosh nets) nest removal, the use of highly toxic organophosphorus pesticides, and fertility control (conraceptive, egg destruction).

5.1.1.4 *Euodice malabarica* (Indian silverbill)

Family: Estrildidae

The Indian Silverbill's native range extends from east Arabian Peninsula (Saudi Arabia, United Arab Emirates, and east-central Oman), and Indian subcontinent (BirdLife International, 2018). The Indian silverbill expanded its range and was introduced to several countries including west-northers Saudi Arabia, Palestine, Jordan, Bahrain, Kuwait, Qatar, and United States (IUCN, 2021). This species of birds is gregarious and usually found in flocks up to 60 individuals. It feeds mainly on grass seeds, and to a lesser extent on insects and nectar bearing flowers. The Indian silverbill is a very common pet bird, and are bred intensively in cages for trade at the local market.

Local distribution: The Indian silverbill is a resident breeding in the Dead Sea depression, Jordan Valley, and the eastern slopes of the West Bank area. It inhabits low-laying, dry, open desert and semi-desert areas mainly in patches of grassland, cultivated plantations (mainly date palm with shrubby undergrowth), and spars scrub-and-bushy areas, especially near water.

Pathways: The Indian silverbill was first recorded in historical Palestine in 1983, and was most probably released from captivity elsewhere in the Arabian Peninsula (Northwester Saudi Arabian) and expanded its range to our region. In addition, some individuals escaped from captivity in historical Palestine (Roll et al., 2008). Until 1996, the Indian silverbill population was limited to the northwestern part of the Dead Sea area and west-central parts of Jericho area (Shirihi, 1996). Thereafter, the population of the Indian silverbill expanded in numbers and range to cover the area between the Dead Sea and along the Jordan valley, in dispersed patches. However, the highest populations of this species are distributed along the west Northern parts of the Dead Sea area (e.g., Ein Fashkha nature reserve) and the whole area of Jericho including the Western Slopes (15 km west of the Jordan River).

Eradication and control: The distribution of the Indian silverbill in Palestine during the last two decades is limited to the Jordan Valley from Dead Sea in the south to Bardaleh in the north, and no further expantion occurred. Therefore, there is no urgent need for any eradication

or control actions. However, several methods can be used to eradicate and control the species including leathal shooting, traping, egg destruction, and nest removal.

Potential threats: The Indian silverbill feeds on grass seeds, and crop species of small seeds including different type of legumes species, and other crops such as Sesame seeds. The bird does not impose any noticeable threats to human, biodiversity, and ecosystem, and impose minimal threats to agricultural crops.

5.1.2 Mammals

Four invasive mammalian species were documented in historical Palestine; two of them inhabit the West Bank, namely; *Myocastor coypu* and *Rattus rattus*. However, according to Roll et al. (2008) and Meiri et al. (2019), the Black rat (*Rattus rattus*) is currently consided as native and not an invasive species, but archeozoological material needs more review and research. The Black rat may well have invaded historical Palestine during the Roman era and the same time spread into Europe. Roll et al. (2008) mentioned that the Indian palm squirrel, which is an invasive species, was reported at the Negev area, however, after this observation, no additional data was found to indicate its distribution or status. Therefore, *Rattus rattus* is considered as an unsuccessful invader. The Brown rat is an invasive species that was not documented in the West Bank yet, but it is reported in historical Palestine (Qumsiyeh, 1966).

5.1.2.1 Myocastor *coypu* (Coypu, Nutria)

Family: Echimyidae

Brief description: The Coypu or the Nutria is a large herbivorous and semi-aquatic rodent (5-9 kg; 40-60 cm body; 30-45 cm tail) native to south America (Qumsiyeh, 1996). It lives in burrows along the side stretches of water bodies, and feeds on aquatic plant stems of different species. Its pelage is brown and yellow-brownish in color; it has cylindrical tail, webbed hind feet, with prominent incisors that are bright orange-yellow and white marks on muzzle (Woods et al. 1992, Carter and Leonard 2002). Its faeces are cylindrical in shape, up to 70mm long,

with fine longitudinal striations (LeBlanc, 1994). *Myocastor coypus* breed throughout the year and becomes sexually mature at age between 3-10 months. The gestation period in this species is between 127-138 days, and the mean litter sizes is between 5-6. The Coypu prefers habitats near permanent water, mainly reed beds, swamps, marches, rivers, streams, and lakes.

Pathway: The *Myocastro coypu* was introduced to Palestine during 1950s from Chile to establish fur farms in Kfar Masarky and Kfar Ruppin for business. However, the fur business collapsed in the 1970-1980, where some populations escaped or were released to the wild and eventually established feral populations in different suitable habitats. (Qumsiyeh, 1996; Roll et al., 2008).

Vector: Currently the natural spread of *Myocastro coypu* is extremely difficult, unless humans interfere and move individuals to other suitable habitats.
Distribution: This species is only reported from a single site at Wadi Al Mokata' in Jenin district in West Bank of Palestine. The species comprises a couple of dozens only (map 5).

Control and Eradication: Several methods are used to control and eradicate the Nutria, mainly by shooting and trapping. Capturing the species by cage traps or by special nets is effective in small to medium size populations. A fence with buried pipelines may also work by putting it around the populated area to contain the individuals. In some countries, the Nutria is hunted, but since they are nocturnal species, hunting might be a challenge.

Potential Threats: *Myocastor coypus* burrows undermine the banks of rivers and streams creating series of burrows in the soil causing instability and habitat distruction (Carter and Leonard, 2002, Khoury et al., 2012). It also feeds on the rhizomes and young shoots of several plant species, which might lead to breakdown of plant communities. Several local observations indicated that *Myocastor coypus* might negatively affect the breeding of water birds like the Moorhen and Black-winged stilt, which was also documented worldwide. (Bertolino et al., 2005; Carter and Leonard, 2002; Panzacchi et al., 2007).

5.1.3 Reptiles

Reptilian biodiversity in western Asia is relatively high due to its geologic history and being a connection between Asia, Europe, and Africa. Herpetological studies in Palestine started in the 19th century (Boettger, 1879; Tristram, 1884; Hart, 1891; Peracca, 1894; Werner, 1898). In historical Palestine, 97 species of reptiles were documented in different habitats (Werner, 2016), of which 36 species were documented in the West Bank, belonging to 13 families. (Handal et al., 2016), and 18 species of reptiles were recorded in Gaza Strip (Abd Rabou et al. 2007). Three invasive alien species of reptiles were documented in historical Palestine, one freshwater turtle (*Trachemys scripta)* and two geckos, the *Cyrtopodion scabrum* and *Tarentola annularis*. These invasive species belong to three families (Emydidae, Gekkonidae, and Phyllodactylidae) respectively. The *Tarentola annularis* was first recorded in 2014 by

capturing three specimens near Ein Gedi, however, no further information is available. (Jamison et al., 2017). The *Cyrtopodion scabrum* gecko was only reported in Eilat, and it is believed that it came to the region from Sinai (Werner, 2016). Only one alien species of reptiles is documented in the West Bank, which is the Red-Eared Slider (*Trachemys scripta elegans*). A single individual was recorded in the second pond in Solomon's Pools, most probably, it was released by humans. Therefore, the species is considered as alien reptile species but not invasive yet.

The Red-Eared Slider (*Trachemys scripta elegans*). A single record of reptilian alien species found at Solomon pools in Behtlehem district.

5.2 Invertebrate

Invertebrates are the most dominant group of introduced species worldwide, and most of these species became invasive and serious pests to their introduced habitat and hosts. Many studies focus on the effect of larger invasive species such as mammals, birds, and reptiles, but fewer studies were conducted on invertebrate fauna in the area of ecology, phenology, and invasiveness.

5.2.1 Insects

Insects are the largest group of animals on earth, and can be found worldwide, and are the most dangerous and distributed invasive alien species. These insects have many dark sides that could affect their environment. They are pests on wild and domesticated flora, economically dangerous, and a health hazard for transmitting diseases (Mazza and Tricarico, 2018; Marbuah et al., 2014).

Most of our knowledge related to invasive alien species of insects depends on old literature and studies from the past century that mainly have lists of introduced species to historical Palestine. Bodenhimer (1935 and 1937) conducted an intensive study regarding the fauna of Palestine, which included both vertebrates and invertebrates. His work showed the existing species in historical Palestine and discussed Tristram's (1865) findings and elucidated about species and their ecology. On the other hand, his book (Bodenhimer, 1937) provided a list, for the first time, of all recorded fauna species, sorted them by order and families including all known insect species. This reference is considered the first and the most valuable database for the fauna of Palestine and surrounding area at that time.

The term introduced or invasive insect species was first used in the 1960s, where more than 190 invasive insects and mites's species were documented in historical Palestine (Bytinski-Salz, 1966). Bytinski-Salz showed that 175 species of the introduced insects belong to more than 40 different families and 9 orders, the Hemipteroidea were the largest order of recorded insects, which are considered as pest invading domesticated crops and wild plants. The other 15 species are mites belonging to the order Acarina and grouped into 3 families.

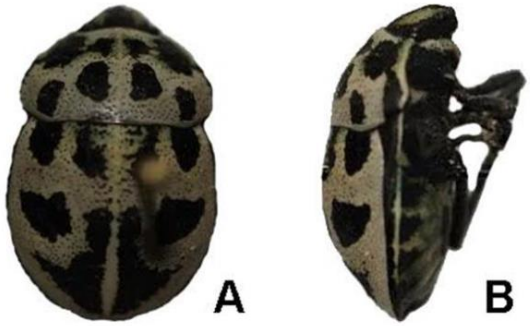
In the past 20 years, some studies have discussed invasive species in Palestine focusing on the phenology and ecology of these species in an attempt to understand their effect on humans, biodiversity, and economy. For example, (Handal 2017; Handal and Qumsiyeh, 2019; Novoselsky and Freidberg, 2013; van der Heyden, 2019; Yathom, 1980, Novoselsky et al., 2015), Coleoptera (Friedman, 2006; Halperin and Friedman, 2003; Soroker et al., 2005, Friedman, 2018; Friedman, 2008; Legaloy and Friedman, 2007), Lepidoptera (Seplyarsky et al., 2010; Ben-Yakir et al., 2013; Yaacouby and Seplyarsky, 2011), long horned beetle (Friedman et al., 2008), Curculionidae (Friedman, 2009; 2006), ants (Vonshak et al., 2010), Diptera (Adawi, 2012), Lepidoptera (Ben-Yakir et al., 2013; Seplyarsky et al., 2010).

A recent study on invasive insect species was conducted by Roll *and* colleagues in 2007, showed that a total of 414 invasive insect species occur in the region, of which 218 species are established invasive alien species in the area (Roll *et al* 2007). The study was based on literature review, examination of specimens at local museums, and discussions with experts, and did not focus on the West Bank nor Gaza.

Locally, few research focused on invasive invertebrates (species list, status, and distribution) in Palestine. Some studies focused on individual species within the class Insecta including *Aedes albopictus* mosquito (Adawi, 2012), *Deroplax silphoides* and *Leptoglossus occidentalis* true bugs (Handal, 2017 and Handal & Qumsiyeh, 2019), and *Rhynchophorus ferrugineus* Red Palm Weevil, which is one of the most common invasive insects in the West Bank (Abu- Qaoud 2015). For the Mollusca group, three land snails and one freshwater snail were partially studied and documented in the West Bank including *Cornu aspersum, Cochlicella acuta, Rumina decollate, and Pseudoplotia scabra*) (Handal et al., 2015 and Handal, 2018).

Species List:

5.2.1.1. *Deroplax silphoides* (scutellerid shield bug)



Description: The Family Scutelleridae includes 80 genera and around 500 described species (Tsai et al. 2011), with 24 species recorded in historical Palestine (Linnavuori 1960, 1961 and 1973; Göllner-Scheiding 2006), including *Deroplax silphoides.* The species is native to the afrotropical region from Madagascar and South Africa northward to Ethiopia in the east and to Senegal on the Atlantic Ocean in the west (Gadallah et al., 2019; Göllner-Scheiding 2006; Schouteden 1903). Its color varies considerably from dark yellow with greenish and black spots dorsally; antennae, labium, thorax and abdominal sterna, femora, tibiae and all tarsomeres black; coxa, trochanter, claws brown; venter of abdomen yellowish green with black markings in females, black in males. Male length is 10.4–11.3 mm, width 6.2–6.6 mm; female length 11.2–12.0 mm, width 6.8–7.4 mm (Novoselsky et al., 2015). The species reproduces twice a year, being more abundant in June. Newly hatched nymphs stay around the egg mass, without feeding, until they molt into the second instar. Third to fifth instars aggregate around immature and ripe seeds. Adults and second to fifth instars feed on seeds and move between branches and leaves. It is also documented that they feed by sucking sap from flowers and green seeds and sometimes from the very tender young apical leaves of the host plant.

Pathway: The species is a pest of ornamental plants (Novoselsky et al., 2015), mainly found on *Dodonaea viscosa* species that is imported from various countries. It was first documented in Eilat in 2002, central Negev in 2010, and Beer Sheva in 2013.

Vector: The distribution of *Deroplax silphoides* is associated with the distribution range of the exotic *Dodonaea viscosa* species, as it was observed feeding exclusively on this ornamental plant (Handal 2017, Novoselsky et al., 2015).

Distribution: *Deroplax silphoides* was documented in Beit Sahour in 2017, and no further documentation of the species in Palestine was reported, because of limited research conducted on this species (status and distribution).

Eradication and control: No information is available regarding the eradication and control of this species, at the regional or global level.

Potential threats: Species of the family Scutelleridae are considered as pests for wheat, however, there is a lack of studies focusing on threats imposed by *Deroplax silphoides* on other plant taxa, agricultural crops, or human health.

5.2.1.2. *Leptoglossus occidentalis* (Western Conifer Seed Bug)

Description: The family Coreidae of the insect suborder Heteroptera has 270 genera and around 1900 described species worldwide (Henry 2009; Packauskas 2010). The genus *Leptoglossus* has sixty-one species restricted to the Nearctic ecozone except the *L. occidentalis* (Heidemann, 1910), a true bug (Hemiptera) native to North America west of the Rocky Mountains that invade many countries including europe (Brailovsky 2014). This bug species has a length between 6–20 mm, where males are smaller than females. It feeds on the sap of developing conifer cones; however, it is documented that they feed on angiosperm species as well. The female lays eggs on the needles or leaf stems of *Pinus* plant species, and hatch in spring. *L. occidentalis* emit an unpleasant-smelling alarm pheromone that function primary as a defense mechanism. The species is unable to cause injury to humans, since it is only adapted to suck plant sap and do not inject poison (Benelli et l., 2014).

Pathway: *Leptoglossus occidentalis* was first recorded in Europe (Italy) in 1999 (Taylor et al. 2001), followed by observations in further parts of Europe and then in Turkey in 2009 (Arslangündoğdu and Hizal 2010; Fent and Kment, 2011). From Turkey, the species started to spread southwards to Lebanon (Nemer 2015) and the nearby Syrian Golan Heights (van der Heyden 2018), and then to Palestine (Handal and Qumsiyeh, 2019).

Vector: *Leptoglossus occidentalis* inhabits coniferous trees, and is suspected to spread through planting infected *Pinus sp.* in Palestine (Handal and Qumsiyeh, 2019). The main source *of Pinus sp* in Palestine are the Ministry of agriculture nurseries as well as the private nurseries, which paly a major role in spreading *L. occidentalis* through distributing the host tree.

Distribution: A living specimen of *L. occidentalis* was collected from Wadi Al-Makhrour under a pine tree of *Pinus halepensis*, and this record is considered the most southern known distribution of this species (Handal and Qumsiyeh, 2019). *L. occidentalis* most probably occurs in several coniferous forests in the West Bank.

Control/ eradication: A study carried out in Italy shows that the use of *Gryon pennsylvanicum* as a natural enemy for the Western conifer seed bug is effective. The eggs of the Western conifer seed bug act as a host for *Gryon pennsylvanicum* (Roversi et al., 2011).

Potential threats this species inhabits and reproduces on pine trees by sucking water from the seeds and inhibiting its life cycle (Handal and Qumsiyeh, 2019). In addition, this bug causes abortion to immature cones of *Pinus pinea*, affecting the pine-nut industry (Roversi et al., 2011). However, almost all coniferous trees in Palestine are not indigenous trees, planted by the British mandate and by the Jordanians.

5.2.1.3.*Periplaneta americana* (American cockroach)

Description: *Periplaneta americana* is an omnivorous species and opportunistic feeder, native to South America. It is one of the largest species of the common cockroach, its body size (length) can reach up to 4 cm, and among cockroaches *P. americana* has the longest lifecycle that could be as long as to 700 days. The cockroach has three developmental stages: egg, nymph, and adult. *P. Americana* is reddish brown in color, its body is flattened, broadly oval, with a shield-like pronotum covering its head. The pronotum is a plate-like structure with yellowish margins. The cockroach has chewing mouthparts, long and segmented antennae, and leathery fore wings with delicate hind wings. *P. americana's* pair of eyes are large, compound, and each having over 3500 individual lenses. *P. americana* is a nocturnal insect, avoids light, and considered among the fastest running insects, rapidly reproducing, and easily spreading.

Pathway: *P. americana* is one of the earliest documented cockroach species that was introduced to historical Palestine. Most probably it came from South America through commerce, inside imported boxes, containers, furniture, etc, (Bodenhimer, 1935), and confined to human settlements (Bytinski-Salz, 1966), living in houses, basements and sewers and may move outdoors into yards during warm weather.

Vector: *P. americana* first detected in historical Palestine in 1928 in the Benjamina railway shed (Bodenhimer, 1935). This species is considered as an outdoor species and is found in gardens and under objects such as rocks, trash barrels and scrap materials. It is spreading all over Palestine through transportation of goods and products.

Distribution: *P. americana* is found in all built-up and urban areas all over Palestine, in buildings, houses, restaurants, storage places, grocery stores, bakeries, and anywhere food is prepared and stored, sewers, and drainage systems etc. as well as open areas between buildings in moist shady areas.

Control/ eradication: An integrated pest management approach is best for *P. americana*. Controlling cockroaches in houses, restaurants, etc., starts with sanitation, including cleaning, reducing access to food, reducing access points to building and other infrastructures, and chemical control. Using insecticides such as ingested poison boric acid, chlorpyrifos, fipronil, and hydramethylnon (Buczkowski et al., 2001), are very effected to control *P. americana.* Loose, toxic, pellet baits are extremely effective in controlling *P. americana* populations, as well.

Potential threats: *P. Americana* can become a public health problem due to their association with human waste and disease and their ability to move from sewers into homes and commercial establishments. *P. americana* odorous secretions are considered nasty, especially in aggregated population. The species is known to be a host for several bacterial species and could transmit *Salmonella*. At least 22 species of pathogenic human bacteria, virus, fungi, and protozoans, as well as 5 species of helminthic worms, have been isolated from field-collected individuals (Rust et al., 1991).

5.2.1.4. *Batocera rufomaculata* (Fig borer, mango tree borer)

Breif Description: *Batocera rufomaculata* is a large insect species of the family Cerambycidae, native to southern China through Malaya, India, Sri Lanka, Madagascar and Mauritius and to eastern Africa (Avidov & Harpaz 1969, Katbeh-bader 1996). It is one of the biggest long horned beetles, adults are 3-5 cm in length. They are dark with a fine greyish vestiture, pronotum with 2 kidney-shaped orange-yellow spots, the basal third of the elytra with numerous black tubercles, and several yellowish spots that are variable in number and shape. Fully-grown larvae are cream colored with a dark brown head, and are up to 10 cm long. The female cuts an incision in twigs or in damaged tree bark, places its single eggs into these cuts, laying about 250 eggs during late summer. The larva development often requires more than one year, and it tunnels into the trunk or branches, causing serious damage to the host tree.

Pupation of *B. rufomaculata* takes place within the stem, the adult beetles emerging in late summer. It is a nocturnal beetle that may live for several months and can fly for long distances.

Pathway: *B. rufomaculata* was most probably introduced into historical Palestine from Sri-Lanka, in 1949, and first recorded from carmel area in 1950 (Bytinski-Salz 1966, Avidov & Harpaz 1969, Ben-Yehuda et al., 2000). This species disappeared between the 1960s and 1980s and was re-documented in the early 1990s.

Vector: *B. rufomaculata* is spreading in Palestine through planting and distributing infected host trees or cut wood of host trees that contain the eggs or the larva of the species, such as fig, mango, guava, jackfruit, pomegranate and walnut trees. In addition, the species is known to fly for relatively long distances, which facilitates its movement from one site to another.

Distribution: *B. rufomaculata* in Palestine was documented in several sites including the Botanical Garden of Talitha Qumi School's compound in Bethlehem district and Dair Ballout in Salfit district, during 2020. However, this species is well known to occur all over the West Bank area, mainly in fig orchads.

Eradication and control:

Physical control: Cleaning out the entry holes of the B. *rufomaculata into infected tree* with a metal hook and then plugging the holes with clothe or cotton wool soaked in kerosene oil, crude oil or formalin will kill the larvae. Other methods involve cutting down infested trees, sawing off severely affected branches, and removal of alternate host plants.

Chemical Control: The application of insecticides such as Organophosphates and Neonicotinoids into infected trees in late summer kills B. *rufomaculata* eggs and young larvae, however, it may also cause leaf and fruit burns. In addition, older larvae hiding in borrows can be killed in-situ by the injection of a volatile liquid or fumigant.

Potential threats: The fig borer is a serious pest of host plants. Infestations may lead to yield losses and even to the death of trees. Damage is mainly caused by the larvae, which initially bore in the trees' sub-cortex and later move deeper into the tree. Continuous tunnelling weakens the wood, causing branches to break and/or the main stem to collapse. The adults chew on green growing tips and on the bark of twigs. The fig borer is a serious pest of fig, mango, guava, pomegranate and walnut in different parts of the world including Palestine.

5.2.1.5. *Rhynchophorus ferrugineus* (Red palm weevil)

Description: *Rhynchophorus ferrugineus* is a highly invasive pest of palms trees, native to southern Asia (Pakistan eastwards to Taiwan, Philippines and Melanesia). The adult beetles are relatively large (2-4 cm) with females 10 to 15% larger than males. The weevil's color ranges from entirely orange-red to all black with all intermediates, depending on the number and size of black marks, the legs are paler, and elytra is shining and slightly pubescent. The head extends with a long thin rostrum that holds the antennae and tiny mandibles. The red palm weevil is a concealed tissue borer pest, it is a lethal pest of palm trees and it is documented to attack 17 different palm tree species worldwide. Eggs are creamy white, oblong and shiny, ranging in size from 2.62 mm long and 1.12 mm wide (Menon and Pandalai, 1960), and hatch in 3 days and increase in size before hatching (Reginald, 1973). Larvae are creamy white, legless, pyriform with a brown head, while the body is comprised of 13 segments, and can grow up to 35-50 mm long, and mean width is about 22 mm in the middle. Fully-grown larvae migrate to the periphery of the palms to build a solid oval-shaped cocoon of fiber (Menon and Pandalai, 1960) made of rolled-up palm fiber. After the cocoon is formed, the larva enters a pre-pupal stage that last for 3 days, its body contracts and it does not crawl any more. The pupal case can range in length from 50-95 mm and in width from 25-40 mm. The color of the pupae at first is cream colored change to brown in later stages. The pupae's surface is shiny, but greatly furrowed and reticulated, 35 mm length and 15 mm in width.

Pathway: *R. ferrugineus* was first documented in Palestine during the summer of 1999 on date palm plantations in the Jordan Valley, in the western bank of the Jordan River and in the northern area of the Dead Sea (Kehat, 1999; Soroker et al., 2005). Most probably the weevil came through imported date palm trees from other countries, as the Palm weevil lays its eggs in wounds along the trunk or in petioles the white larva can be found in the bole, stem or crown of young palm trees (Blumberg, 2008). In addition, since female *R. ferrugineus* is capable of flying, relatively long distances, it probably crossed from the eastern bank of the Jordan valley and Dead Sea area on the Jordanian side to Palestine (Jordan Valley and Dead Sea area).

Vector: *R. ferrugineus* is spreading in Palestine through planting uninspected and infected date palm trees in different areas, moving planting material from infested plantations to different

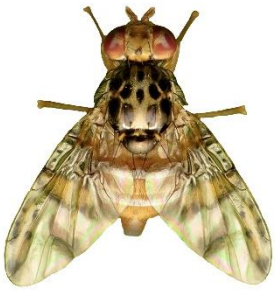
sites, and improper discarding of infected trees or planting materials. In addition, the adult female can fly, covering long distances, and possible infect new date palm plantations.

Distribution: *R. ferrugineus* was documented in palm date plantations from Jericho to Marj Na'jeh in the Jordan Valley, and in date plantations in Jifftlik area. It was also documented in the date palm trees in Bethlehem, Beit Sahour, Salfit, and Jenin areas, in addition to Gaza strip. (Abd Rabou and Radwan, 2017).

Eradication and control: Several methods were developed to control and manage the spread of red palm weevil. These methods include using well-trained dogs to detect the species at the pupa and larvae stage in infected trees (Nakash et al., 2000). As well as using special detectors such as the Davis Red Weevil Detector, which is an electronic instrument capable of amplifying the noise made by *R. ferrugineus* larvae. After detecting the larva, insecticides such as a combination of trunk injections and sprays with carbaryl, fipronil, and imidacloprid found to provide the highest efficacy against *R. ferrugineus*. Another effective method is using aggregation pheromones to mass-trap for detecting adult weevils (Faleiro and Chellapan, 1999). Ferrugineol-based pheromone lures together with food bait, such as sugarcane, was used successfully to obtain higher catches of the weevil. (Guarino et al., 2015; Soroker et al., 2005; Blimberg 2008). Using ground traps with some chemicals like Ethyl acetate shows improvement against this invasive pest as well (Soroker et al., 2005). To control this species, it should be detected in the early stages of invasion, as date palm trees respond effectively to chemical treatment in the early stages of attack with insecticide. Most importantly, to control this species, all movement of planting material from infested plantations within the country needs to be stopped and controlled (Faleiro, 2006).

Potential threats: the red palm weevil is a pest insect of date palm trees in our region. Its reproduction and life cycle destroys and eventually kills the host tree. (Soroker et al., 2005). Therefore, infestations of red palm weevil have a tremendous impact on the economic product of the palm (dates) and on the society as well, since date palm is closely associated with our culture, religion and the life of the Palestinian communities.

5.2.1.6.*Ceratitis capitata* (Mediterranean fruit fly)



Description: *Ceratitis capitata* is an endemic to most Sub-Saharan countries. The adult medfly is 4 to 5 mm long and the body is yellowish in color with a tinge of brown, especially at the abdomen, and legs. It has an oval shaped abdomen that is clothed on the upper surface with fine and scattered black bristles. The female has a long ovipositor at the apex of the abdomen, unlike the male. The c. capitata eggs are very slender, curved, 1mm long, smooth and shiny white, deposited under the skin of fruit that is just beginning to ripen. The larvae are cylindrical maggot-shape, elongate, anterior end narrowed and somewhat recurved ventrally, with anterior mouth hooks, and flattened caudal end. The pupae are cylindrical, about 3mm long and dark reddish brown in color (Mau and Kessing, 1992). Adult *C. capitata* flies have been recorded to have an average life span for males of 11 weeks and for females of 9 weeks (Carey et al. 2008). It is as one of the most destructive fruit pests in the world, and ranked first among economically important fruit fly species. The medfly is documented to attack more than 300 different temperate and subtropical fruits (Liquido et al. 1991), therefore, it has a massive economic impact, and in particular, where the species has been introduced.

Pathway: *C. capitata* was documented for the first time in historical Palestine in early 1900s, throughout imported tropical fruits from Morocco (Bytinski-Salz, 1966).

Vector: *C. capitata* is spreading in Palestine through commercially distributing contaminated fruits with the eggs or the larvae, and dominant in agricultural farms and house gardens.

Distribution: *C. capitata* is considered as a wide distributed invasive species in Palestine. It was documented in Tulkarem, Qalqylia, Jericho, Tubas, Jenin, Bethlehem, and Hebron district using yellow sticky traps. The species was located among citrus groves and other fruit trees.

Control/ eradication:

Biological control: There are several tested and applied methods to control the spread of *C. capitate*, for example the sterile insect technique (SIT), which is an environment-friendly insect pest control technique. This method involves mass-rearing and sterilization of *C. capitate* populations in labs, followed by systematic release of sterile males by air over defined areas, where they mate with wild females resulting in no offspring, therefore, declining the pest population. This method is used in Mexico, Australia and showed a decline in the pest population (Fisher et al., 1985; Hendrichs et al., 1983; Jang et al. 2003).

Natural enemies: Several insect species were used as a natural enemy to fight the *C. capitate*. The most two significant species used are *Biosteres* and *Opius sps* (Both are micro wasps of the order Hymenoptera), these parasites lay their eggs inside the *C. capitate* larvae (Clausen, 1978) and eventually kill them. This method showed a good result of 25-55% efficacy.

Physical control: Trapping is not recommended as a control option but is useful for early detection to prevent establishment of populations, using lures and attractants.

Chemical Control: Using foliage baiting and cover spraying are found to be an effective technique to control *C. capitate*. The foliage bait contains protein and insecticides which attracts both males and females's medfly. Cover spraying controls all life stages through contact and penetrative action. Both methods can be applied together, depending on the level of infestations.

Potential threats: *C. capitata* is considered as a major pest of economic importance attacking more than 300 different tropical and subtropical fruits. It is highly polyphagous and causes damage to a very wide range of unrelated fruit crops. In the Mediterranean countries, it is particularly damaging to citrus and peach trees. It may also transmit fruit-rotting fungi (Cayol et al., 1994). Damage to fruit crops is frequently high and may reach 100% (Fimiani, 1989; Fischer-Colbrie and Busch-Petersen, 1989). In our region, the medfly is considered as a major pest to all citrus and stone fruits (Peaches, Plums, Apricot mango), fig, guava, feijoa, persimmon, loquat, prickly pear, grapes, carambola (starfruit), quince, Ziziphus, apple, pear, avocado and pomegranate. Medfly also infests a few vegetable species such as red pepper and tomato (Gazit, 2015).

5.2.1.7.*Myopardalis pardalina* (Baluchistan Melon Fly)

Description: *Myopardalis pardalina* was originally described from Baluchistan, an area extending from Southeastern Iran to Western Pakistan. It is a small fly, with a red head and eyes, black thorax and abdomen, with a yellow plate located between the thorax and the abdomen. Wings with three stripes (dark). This species belongs to the family Tephritidae It is considered a serious pest for melon, watermelon, and cucumber. *M. pardalina* is smaller than

the fruit fly, and can reproduce three times a year (Ullah et al., 2015). The adult female of *M. pardalina* is about 6 mm in length and lays about 60 and 110 eggs each time under the skin of unripe fruits or the host plant, these eggs hatch after 3 to 4 days which a white larvae eat the pulp and. After that the larva reaches about 10 millimeters in length, then they leave the fruit to pupate underground (Ullah et al., 2015). The main host plant of *M. pardalina* is *Cucumis melo* (melon), but other cultivated Cucurbitaceae can be attacked including *Citrullus lanatus* (watermelon), *Cucumis sativus* (cucumber), as well as weeds (*Cucumis trigonus, Ecballium elaterium*). In the Middle East, the fly is a minor, occasional pest of melons and watermelons.

Pathway: the first documentation of *M. pardalina* in historical Palestine was in 1919 in Tulkarem, and Kfar Kanna in 1938. It was only found again in 1957 in the costal plain. It is believed that *M. pardalina* arrived through commerce and trading, mainly through imported fruits of host plants (Bytinski-Salz, 1966).

Vector: The *M. pardalina* invasive species is spreading in Palestine through distributing of fruits of host plants in local markets, or through nurseries distributing seedlings of host plants. Another possible spreading mechanism is through transporting soil from infected sites. Adult *M. pardalina* can fly but there is no assessment on their flying capacity, but still, this is a possible spreading mechanism of the species, at least for short distances.

Distribution: The *M. pardalina* distribution is not well documented in Palestine, but it was recorded in Tulkarem, Qalqilya, Jericho, Jenin, and tubas using the yellow sticky traps in watermelon and melon crops.

Control/ eradication:

Horticultural methods: Collecting, disposing, and destruction of infested fruits is a very important step to minimize the infestation rate by *M. pardalina.* Infected fruits are identified by the insect exit-holes. Sanitation and removal of weeds around cucurbit fields is essential.

Chemical control: the use of Pyrethroids insecticides, such as deltamethrin, augmented with sugar, and carbamates, applied by dusting the soil surface, provided the best results. In addition, baits of a protein hydrolysate augmented with an insecticide and sugar is an effective approach as well.

Potential threats: *M. pardalina* is a pest on Cucurbitaceae species, it could make a secondary contamination for infected fruits with bacteria and fungus, making them inadequate for human consumptions. In numerous countries such as Afghanistan, Turkmenistan, and Uzbekistan, losses in melon and watermelon crops might reach up to 80-90% in some years (Ullah et al., 2015).

5.2.1.8. *Aedes albopictus* (Asian tiger mosquito)

Description: The tiger mosquitoe is native to the Oriental Region from the tropics of Southeast Asia, the Pacific and Indian Ocean Islands, north through China and Japan and west to Madagascar (Gratz, 2004). *Aedes albopictus* are fragile insects with slender bodies and an elongate proboscis, one pair of narrow wings, and three pairs of long, slender legs. Adults are known as tiger mosquitoes because of their noticeable patterns of very black bodies with white stripes, which also make them easily recognized. The scutum is black with a distinguished white stripe down to the central beginning at the dorsal surface of the head and continuing along the thorax (Adawi, 2012). The adult mosquito can reach up to 10 mm in length, with a striking white and black pattern on the abdomen and thorax. The variation of the body size in adult mosquitoes depends on the density of the larval population and food supply in breeding water bodies (Estrada-Franco and Craig, 1995; Aida et al., 2011; Hawley, 1988). *A. albopictus* is a tree-hole mosquito, its breeding places in nature are small, restricted, shaded bodies of water in densely vegetated rural areas, but it colonizes many types of manmade sites and urban regions because of its ecological flexibility. *A. albopcitus* is a nectarivores insect, obtaining needed energy and nutrients by feeding on flowering plants, but the females require mammalian blood to produce eggs, though will accept blood from a wide variety of hosts.

Pathway: *A. albopictus* was first documented in historical Palestine during 2002, at the southern coastal plain (Pener et al., 2003), were it started to expand its range to other areas (Muller et al., 2010). Most probably, it was brought through commerce and shipping via dormant eggs in tires (Gratz, 2004). In 2012, it was documented for the first time in Palestine, specifically in Salfit district (Adawi, 2021), and since then it invaded other districts in Palestine.

Vectors: *A. albopictus* is spreading through transporting of habitat material, such as the movement of moist vegetation and soil, wet-used tires, or water containers that can hold eggs or larvae (Eritja et al. 2005). In addition, the adult flight range is quite short, therefore, the spreading of tiger mosquitoes is quite slow but it helps the species expand their range. The larva of this species can be found in different habitats, which make it easy to increase its distribution and invasion (Adawi, 2012).

Distribution: Since 2021, the tiger mosquitoes invaded several districts in Palestine; including Salfit, Bethlehem, Ramallah and Nablus. Nevertheless, the distribution of *A. alobopictus* is

most probably all over Palestine, but more research is needed to examine and evaluate its current distribution range.

Control and eradication

Chemical control: *A. alobopictus* is a very aggressive invasive alien species to suppress or to control, because of its remarkable ability to adapt to various environments and habitat, its close contact with humans, and its reproductive biology (Adawi, 2012). Fog chemical can be implimented using 15% dieldrin (88 ml/ hectare) with SwingFog portable thermal fog generator to control adult mosquitos of *A. alobopictus* (Estrada-Franco and Craig, 1995).

Physical Control: *A. alobopictus* can be captured with recently developed traps, the BG-SentinelTM and the Collapsible Mosquito Trap (CMT-20TM). These traps use ammonia, fatty acids and lactic acids to produce a smell similar to that of a human body in an upward air current, while the addition of carbon dioxide greatly improves the number of mosquitoes captured (Meeraus et al. 2008).

Biological Control: In north America, the species *Toxorhynchites splendens* was found to be a utilizer for the *A. albopictus* and other mosquito species, which eliminates the *A. albopictus* from invaded areas, by reducing the breeding acceleration of the species (Estrada-Franco and Craig, 1995).

Horticulture Control: another approach of controlling the spread of the tiger mosquitoes is by disrupting its life cycle by eliminating its breeding habitats such as destroying unwanted water bodies such as water barrels in the agricultural fields used for irrigation, or covering water surfaces to reduce potential breeding habitats (Estrada-Franco and Craig, 1995).

Potential threats: *A. albopictus* poses a potential threat to human health, as it shows the ability to host more than 20 arboviruses that could infect humans (Adawi, 2012; Gratz, 2004), *A. albopictus* is one of the possible vectors for dengue, chikungunya (CHIK), and Encephalitis viruses (Labbé et al., 2012).

5.2.1.9. *Tuta absoluta* (The South American tomato moth)

Brief Description: *Tuta absoluta* is a small moth with a body length of 5-7 mm and a wingspan of 10-14 mm, native to Peruvian central highlands in south America, and spread to other areas of Peru and then to the rest of Latin American countries during the 1960s. The moth belongs to the Gelechiidae family commonly known as twirler or gelechiid moths, where over 4500 described species are found in this family, grouped in 900 genera (Donald et al., 1989). The male abdomen is usually longer and slimmer than the female. They are mottled grey in color

and their antennas are long and filiform with alternating light and dark bands. Labial palps (mouthparts) are also banded with light and dark scales and are recurved (curved upwards), the eggs are small reaching 0.36 mm in length and 0.22 mm width, with elliptical shape and creamy white to bright yellow color. Larva is whitish in first instar, about 0.9 mm long, becomes greenish or light pink in the second and fourth instar. The larva of *T. absoluta* feeds voraciously on host plants, producing large galleries in the leaves of the plant, which causes burrowing in stalks and consuming of the apical buds and green and ripe fruits. The pupae are obtect with greenish coloration at first, turning to chestnut brown and dark brown near adult emergence.

Pathway: *T. absoluta* was first documented in historical Palestine in 2009, through applying pheromone traps, which were placed in tomato growing fields (Seplyarsky et al., 2010). The moth was most probably introduced to historical Palestine through importing infected tomato plants, harvested tomato, or seeds from other countries.

Vector: The *T. absoluta* tomato moth was documented on several tomato crops in greenhouses and open fields in Palestine. The species is a nocturnal active species, and can fly and infect other tomato crops. Uncontrolled local nurseries that distribute tomato seedlings and seeds are possible vector of *T. absoluta*. The moth is also spread through harvested tomatoes, as the *T. absoluta* larvae emerge from the fruit post-harvest and pupate in the boxes used for distribution. According to Clarke (1962), this species also is a pest of potatoes, but no records were documented in Palestine.

Distribution: *Tuta absoluta* was documented on tomato plantations in open fields and greenhouses in Jericho district, and different sites within the Jordan Valley, as well as in Bethlehem district in greenhouses. The moth probably invaded all the West Bank area, where tomato is cultivated in greenhouses or open field with suitable conditions.

Control and eradication:

Mechanical control: Several capturing methods have been developed to control and manage the spread of *T. absoluta*, including pheromone traps in combination with pheromone dispensers that attract adult males and females. In addition, hygiene is very important; the removal of crop waste at the end of the season will reduce the number of *T. absoluta* surviving to infest subsequent crops.

Chemical control: Using insecticide such as chlorantraniliprole, thiamethoxam, lufenuron and chlorpyriphos to eradicate *T. absoluta* are effective chemicals with efficiency reaching up 100% (Tayeb et al., 2018).

Biological control: the use of *Nesidiocoris tenuis*, a true bug species of the suborder Heteroptera, as a natural enemy to suppress the population of *T. absoluta* was found to be effective. The bug species works as parasitoids on the *T. absoluta* larva (Shaltiel-Harpaz et al., 2016). The *Trichogramma pretiosum* (order Diptera) is another natural enemy of *T. absoluta* that was found to be effective if used in a ratio of 16 parasitoids per egg host (Pratissoli et al., 2005).

Potential Threats: *T. absoluta* is a major pest for tomato crops, imposing dramatic economic losses to farmers. The most distinctive symptoms of damage done by *T. absoluta* are the blotch-

shaped mines in the leaves. The larva of *T. absoluta* prefer leaves and stems, but they may also occur underneath the crown of the fruit and even inside the fruit itself. In case of serious infection, leaves die off completely. Damage to fruit allows fungal diseases to enter, leading to rotting fruit before or after harvest. In addition, potato, aubergine, common bean, and various wild solanaceous plants are also suitable hosts for *T. absoluta*

5.2.2 Mollusca

Studies on the land snails of historical Palestine date back as far as 1850's (Bourguignat 1852; 1857; Benson 1859; Tristram, 1865). In total 105 species of land snails are known from historical Palestine and the Golan Heights (Heller, 2009). Gastropod, second only behind insects in number of species, play an important role as a bioindicator in the environment including for climate change studies (Goodfriend and Magaritz, 1987; Magaritz and Heller, 1980; Swaileh and Ezzughayyar, 2000; 2001).

About 19 and 33 species of freshwater and terrestrial snails, respectively, are considered invasive to historical Palestine, inhabiting various types of habitats and water bodies. Most of these snails entered through imported seedlings, aquaria fishes, or deliberately introduced for economic reasons as a new food source (Roll *et al*., 2009). Three land snails and two freshwater snails were documented in Palestine, namely (*Cornu aspersum, Cochlicella acuta, Rumina decollate*) and *Pseudoplotia scabra* and *Planorbella duryi* respectively (Handal et al., 2015 and Handal, 2018). T

Species List:

5.2.2.1 Cornu aspersum (Garden Snail)

Family: Helicidae

Description: *Cornu aspersum* species characterized by a relatively large shell reaching up to 30 mm height and 40 mm in diameter. Shell globose in shape with 4.5-5 convex whorls. Umbilicus entirely covered by columelar lip outfold. Aperture very large with outward folded lip. Color yellow to brown with about five spiral bands (Handal, 2018). This is an invasive species of land snails and is now the largest species found in the State of Palestine in size, Roll et al., (2009) suggested that two subspecies occur in (megalostomum and aspersum) (Handal, 2018). The body is soft and slimy, brownish-grey, and able to be retracted entirely into the

shell. It needs 2 years to reach the adult stage to reproduce and lay between 60-80 eggs each time. This species is known commercially as a food source for Humans, and this is the reason for this species to become exotic in several countries.

Pathway: The *C. aspersum* was deliberately introduced from Italy, as well as other European species of Helicidae for the food industry and as alternative agriculture practices. However, some species including *C. aspersum* escaped from the farming facilities, or were released and became an invasive species. No exact dates are known to when these snails were imported to our area or date of escaping.

Vector: The *C. aspersum* are suspected to spread in our area by contaminated soil with its eggs, or by some seedlings of fruit and vegetables plants. This species can move around 50 meter per hour and feeds on several species of fruit and vegetables (Roll et al., 2009, Heller, 2009).

Distribution: *C. aspersum* is recorded only in the botanical gardens of Talitha Qumi compound in Beit Jalla (Handal, 2018), which is considered the southernmost distribution range.

Control/ eradication:

Physical control: Collection of adult snails and eggs by hand where this species lays is an effective approach, but it is time and labor consuming. Another method is to make a pitfall trap using plastic bottle and fill it with any kind of beer, this method is used to collect land snail by attract them to the yeast present in the beer (Moran, 2021).

Natural enemies: arthropod usually can be used as a natural enemy to control land snails, like beetle species of the family carbide, but for this species using concentrated garlic could work (Albuquerque et al., 2008).

Chemical control: Bordeaux mixture (a copper sulphate and hydrated lime mixture) can be brushed on tree trunks to repel snails, (Dreistadt et al., 2004). Thin copper sheets can also be wrapped around tree trunks to prevent snails from climbing into the canopy (Davis et al., 2004; Dreistadt et al., 2004). Application of molluscicides is the most widely implemented approach to controlling snail pests. Molluscicides are generally delivered as baits (e.g., de Boodt et al., 1990), with one of the three major classes of compounds present in molluscicides: metaldehyde, carbamates, and metal chelate such as iron EDTA (Barker and Watts, 2002).

Potential threats: C. aspersum can cause serious losses to various ornamental plants and crops such as cabbage, lettuce, tomato, citrus, avocado, grapevines and other fruits and vegetables. The C. *aspersum* is a host for the fox lungworm (*Crenosoma vulpis*) that effect red foxes, dogs, and badgers and could play an important role for the infection of other wild animals that might lead to death (Collella et al., 2016).

5.2.2.2 Cochlicella barbara (Banded conical snail)

Family: Hygromiidae

Description: *Cochlicella barbara's* shell is thick and small, generally 8-12 mm long and 5-8 mm wide, turreted and conical in shape. Its color ranges from purely whitish-creamy to brown, usually with a brown spiral band, or spiral band dissolved to single blotches. The protoconch is smooth, consisting of 2 creamy colored whorls. The teleoconch has a well-rounded whorl and a suture of medium depth, while the surface is covered by a sculpture of rugose axial wrinkles and riblets; aperture subcircular, peristomal rims straight, sharp; umbilicus narrowly open, slightly covered by a small triangular reflection of the columella (Handal, 2018). This species is widespread at the coastal Mediterranean ecosystems. Visual signs of *C. barbara* can include chewing or rasping damage to plants, presence of eggs, juveniles and adults, empty snail shells, mucus and slime trails, and ribbon like feces. This species is native to Europe, it occurs mostly on the coastal areas from north Portugal to the northwestern Mediterranean area.

Pathway: No exact information on the introduction date of *C. barbara* to historic Palestine, but the introduction of this snail species is associated with imported ornamental plants and artificial soil, especially that distributed by the Ministry of Agriculture.

Vector: *C. barbara* so far was discovered from nurseries of the Palestinian Ministry of Agriculture, in humid plant pots, and not on a specific plant. The distribution of these host plants considered as a major carrier for this invasive species. However, the species was not recorded outside of the nurseries, yet. In addition, the *C. barbara* is considered as a "hitchhiker" pest as it has been documented in ships, vehicles, and containers in some countries (Ekin and Sesen, 2020).

Distribution: *C. barbara* was documented and collected in the Ministry of Agriculture green houses, gardens and nurseries. More studies and observations on this species are needed to understand if it has established new populations in nature (Neubert et al., 2015). The species was observed at Kishda, Al Aroub, Bethlehem, and Jeinin governmental nurseries.

Control/ eradication:

Physical control: *C. barbara* can be controlled by collecting adult individuals and eggs from gardens, nurseries and other invaded areas.

Biological Control: The use of natural predators such as carnivorous beetles of the carabids groups is sometimes used and these beetles can be found naturally in healthy habitats (Godan, 1983; Morrondo et al., 2005).

Potential threats: *C. barbara* is known to be an intermediate host of nematodes and trematodes which infect man and domestic animals by fluke parasites of livestock. These nematodes in some countries seem to affect sheep and ruminants (Ekin and Sesen, 2020). This species also is known to be a pest to small grain and seedling production. It is also a pest in legume-based pastures in Australia and is especially damaging to annual medics, alfalfa clovers, cereals, and oilseeds rape (Baker, 1986).

5.2.2.3 Rumina decollata (Decollate snail)

Family: Subulinidae

Description: *Rumina decollata* is characterized by a large shell, turreted shells. Adult shells are truncate, usually consisting of 3-5 whorls, the teleoconch whorls glossy, white to dark brown, with a sculpture consisting of prominent axial growth lines and fine spiral striae; aperture subcircular, lip simple, sharp, columella broadly reflected, straight; umbilicus slit-like open (Handal, 2018). *R. decollata* is a voracious predator, it feeds on common garden snails and slugs and their eggs, but also on plant matter. However, its damage to plants is minor when compared to its predation on garden snails and other pest species of snails. It is also documented consuming harmless local species of land gastropods, (Handal, 2018, Heller, 2009). This species is native to the Mediterranean basin except the southeastern parts (Mienis, 2003). In its native range, the species is found in dry, open habitats upon calcium-rich soils (Kerney & Cameron, 1979).

Pathway: *R. decollate* is one of the old introduced Mollusca in our area by the Romans from Europe in the ancient times, as well as to Egypt (Roll et al, 2009, Heller, 2009).

Vector: *R. decollate* was only recorded and observed in one spot at Bethlehem University Garden near rose flowers. Possible spreading methods are through transporting soil

contaminated with the snail's eggs, or by transporting immature snails on host plants such as ornamental plants.

Distribution: *R. decollate* was only reported from Bethlehem University Garden, in 2018. The distribution of this invasive species needs further investigation, and studies.

Control and eradication: Decollate snails are one of the easier species to eradicate and control, using a combination of methods such as habitat modification, hand picking, trapping by using pitfall trap, and bait. Modifying habitats can help prevent any kind of pest snail through removal of hiding places such as clumps of vegetation (Fisher and Orth, 1985).

Potential threats: Fisher and Orth, (1985) mentioned that *R. decollate* was introduced to the Mediterranean region and can dominate over other species of land snails.

5.2.2.4 Mieniplotia scabra (Pagoda tiara)

Family: Thiaridae

Description: *Mieniplotia scabra* shell is conical, turreted, with a maximum length of 23 mm. The shell consists of 8-12 whorls, usually the upper whorls shouldered, ribbed, often with upwards pointing spines at the shoulder, or with thickened knob-like ribs on the shoulder; teleoconch whorls with spiral threads; shell colour varying from reddish-yellowish to olive-green with an irregular pattern of red-brown spots or zig-zag like axial flames (Amr et al., 2014). This species is one of the most successful invasive species in many parts of the world (Thompson et al., 2009). Its natural habitat extends over south and southeast Asia, and the Indo-Australian Archipelago, extending eastwards to the western Pacific Islands (Thompson et al., 2009). It is established in many countries in the Arabian Peninsula (Brown & Wright 1980, Brown & Gallagh- er 1985, Neubert, 1998; Feulner & Green, 1999) and Jordan (Amr et al., 2014).

Pathway: *M. scabra* was first documented in histroical Palestine at the lake of Galilee (2004) and started to dominant over native species. It was brought accidentally through transport of aquaculture products such trout eggs and alive fish, as well as, in the guts of introduced farm fish (Heller et al., 2014).

Vector: *M. scabra* started to increase its distribution in historical Palestine by some mammals and aquatic birds (Heller et al., 2014).

Distribution: This species has been introduced to many countries in the Arabian Peninsula, Jordan and Palestine (Amr et al., 2014). This species was documented at the north eastern part of the West Bank near the Jordan River, in a small pond near Ein Sakout.

Control and eradication: Freshwater snails are difficult to manage and control unlike terrestrial snails. Biological control by using predators or natural enemies could work well such as the rainbow trout (*Oncorhynchus mykiss*) and parasites (digenetic trematode *Microphallus sp*.) have been tested in several countries and reported as a good biological control.

Potential threats: *M. scabra* became a dominant species in the Lake of Galilee, reaching up to 95% of the total freshwater snail fauna, and bringing four native species to the brink of extinction namely; *Melanoides, Melanopsis, and Theodoxus* (Heller et al., 2014). Therefore, *P. scabra* has the capability of changing the snails' diversity in natural freshwater habitats.

5.2.2.5 Planorbella duryi (Seminole Ramshorn Snail)

Family: Planorbidae

Description: *Planorbella duryi* is a species of air-breathing freshwater snail, native to North America. It is mainly found in freshwater habitats including streams and ponds, and feeds on algae, detritus dead or decaying plants, and fish. The shells are sinistral, deeply biconcave, the whorls are strongly keeled at whorl shoulder with a flat spire in juveniles, but whorls become more rounded and spire becomes sunken, in adults. Its umbilicus is deep and funnel-like. The egg mass is a jelly strip containing small eggs. They are hermaphrodites like other snails, and are very fast breeders (Alexandrowicz, 2003). Shells of *P. duryi* are pale, pale-olive, or light yellowish-brown and dark brown in some cases, some of them slightly translucent.

Pathway: This species is endemic to Florida, brought to historical Palestine by imported aquatic plants. It reached the West Bank area from Jerusalem botanical Garden.

Vector: *P. duryi* is spread into different aquatic water bodies by dispersal of water plants over short and even long distances, and by birds (Alexandrowicz, 2003). Humans might play a role in spreading the species by transporting contaminated water with aquatic plants from one area to another.

Distribution: *P. duryi* species was recorded only in the botanical garden at the Palestine Museum of Natural History's Pond.

Control and eradication: Some easy methods are used to control and manage *P. duryi* such as using some pesticides and molluscicides (general for snails) (Clearwater et al., 2008). According to Frankel et al, (2019) the use of methoxychlor showed a direct effect on the reproduction, mobility, and egg hatching. The use of methoxychlor causes detrimental effects on several nonlethal endpoints in a nonmodal aquatic invertebrate species and this has a negative effect on the mobility of the species.

Potential threats: This species does not show any threat related to humans, but based on its phenology and ecology, this species can be dominant in the future over other freshwater snail species that are native to our area.

6. Flora

Species List

6.1 *Acacia saligna* (Golden Wreath Wattle, Blue-leafed Wattle)

Family: Fabaceae

Brief description: *Acacia saligna* is a shrub or low tree endemic to southwestern Australia (Fox, J. E. D.1995), with single or multiple trunks reaching 2-6 m tall, but it can form a small tree 5 -9 m high, with a short but well-defined main stem (Midgely & Turnbull, 2003). It is considered as one of the worst invasive plants in Mediterranean climate regions (Cohen, O. et al.2018). The phyllodes of *A. saligna* are dark green, smooth and leathery, they can be linear or canaliculated, with a prominent midrib. The surface of the phyllodes is flat or undulate, 7-

25 cm long and 4-20 mm wide, and have a distinctive gland (1-2 mm) at its base. The inflorescence bearing 2-10 bright yellow globular heads, with a diameter of 7-10 mm, each globular head comprises of 25–55-minute flowers. The pods are straight, with slight constrictions between the seeds, 8-12 cm long and 4-6 mm wide. In historical Palestine, *A. saligna* grows in the Mediterranean climate, but also can penetrate to the edges of semi-arid areas where precipitation can be as low as 240 mm. It grows in most types of soils, including sandy soils and it is resistant to high salinity (up to 10-20 dS/m). *Acacia saligna* trees develop horizontal as well as vertical roots that reach different depth (3.5-16 m). Vegetative reproduction of *A. saligna* is by seeds, producing large numbers of seeds and blooming period in our region extend between end of March and beginning of May. *A. saligna* was tested as a fodder for goats and sheep (Degen et al., 1995), however, the results showed that *A. saligna*, cannot be used as exclusive dietary for small ruminants but can be used supplementary (Degen et al., 1995).

Pathway: *A. saligna* was introduced to historical Palestine in the early years of the British Mandate (1920s) to stabilize sand dunes, afforestation, landscaping, and for its ability to thrive in harsh environments and saline soil (Midgely & Turnbull, 2003). Only in the late 1970s, *A. saligna* has become an invasive species, however, the planting of *A. saligna* continued at least until the 1980s.

Vector: In our region, some studies suggest that a common local ant species, *Pheidole pallidula*, plays a major role in dispersing *A. saligna* seeds, while exposure to fire triggers germination. In the West Bank, the Ministry of Agriculture planted *A. saligna* in different places in efforts to create suitable rangeland for sheep and goats. Other studies from South Africa, showed that ants disperse *A. saligna* seeds to distances of 2-3 m and bury them 4-7 cm in the ground.

Distribution: *A. saligna* is located in different places within the Mediterranean and semi desert regions, in small numbers or patches, from Abu Dies in East Jerusalem to Jenin district, mainly in the central mountainous areas. The species is located in disturbed habitats such as roadsides and wasteland, but also in natural habitats such as slopes of mountainous areas, nature reserves and rangelands. The species is planted by the Ministry of Agriculture in an ongoing afforestation and rangeland rehabilitation efforts, as well as by municipalities, village councils and local communities. *A. saligna* was documented in Jabal Tammoun nature reserve and its surrounding area, eastern parts of Al-Miksar nature reserve, and on the sideroad to Siris. These sites wer planted by the MoA. In addition, it is located in small numbers on the main road between Bethlehem and the eastern parts of Jerusalem to Hizma, and on the main road from Jaba' to Mukhmas village. Few individuals were documented in the west central parts of Ramallah districts (Ein Sinya and west north of Abu Qash). Several individuals were recorded in Azune Atme, and on the main road between Bayt Amin and Abu Salman in Qalqilya district. Few individuals were recorded in west Nablus, near Bayt Wazan, and couple of trees in Jenin city, on the roadside near Alshahada area, on the roadside between Firasin and Qaffin, and few places in Zababida town. In Hebron district, few individuals were recorded on the roadside near Wadi Al Quf protected area, and Ithna city. The species is considered invasive in Palestine.

Control and eradication

Physical control of *A. saligna* is possible (MacDonald & Wissel, 1992) but limited, very laborous and cost intensive as *A. saligna* can easily regenerate following cutting or fire, and uprooting is ineffective as well since some root fragments remain in the soil and regeneration occurs, especially in heavily infested sites. Solarization approach was found to be ineffective method to destroy seed banks for densely populated areas, but for seed banks in experimental plots (Cohen, O.et al.2008, 2018). Based on several assessment studies to control *A. saligna* in South Africa, reduction and neutralization of seed sources was agreed to be the most effective strategy though destroying *A. saligna* over the age of 5 years.

Chemical control of *A. saligna* was found to be very effective by using the drill-fill technique for mature trees with minute amounts of undiluted glyphosate, and the filling method for saplings and seedlings. The success rate of killing mature and young *A. saligna* using the chemical control was more than 80%, easily applied and not expensive, and without the need for repeated applications, but it is a time-consuming method.

Biological control using fungal pathogen "*Uromycladium tepperianum*" which was developed and tested in South Africa successfully, where the density of *A. saligna* trees declined between 87-98%, and the lifespan of the trees declined to 7 years (Holmes, P. M. et al. 1987). However, this method does not affect the seed banks and remain a continuous source of propagules. Another approach was tested by supplement the developed fungal pathogen with seed-feeding weevil "*Melanterius compactus*", which successfully terminates over 90% of the seeds before falling on ground. (Impson, F. A. C. *et al*.2011, Morris, M. J.1997). In our region, no biological control method against *A. saligna* was developed or tested.

Potential threats: *A. saligna* affects native species and ecosystems in several ways. The trees create dense vegetation and large area of shades, which terminate the growth of native species and displace them. *A. saligna* produces thick layer of dead leaves that accumulates beneath the trees, consequently, prevents germination of native species, increases soil nitrogen concentrations that creates favorable conditions for other alien invasive plant species. In dry habitats, dense stands of *A. saligna* was found to reduce soil moisture that is available for native species, particularly woody plants. Another negative effect of *A. saligna* on local ecosystems is the increase of fuel loads, thus, increasing the intensity of fire events.

6.2 *Ailanthus altissima* (Tree of Heaven, Chinese Sumac)

Family: Pontederiaceae

Brief description*: Ailanthus altissima* is a winter deciduous tree, native to eastern and southern China, and north Vietnam (Ingo-Kowarik & Ina Säumel,2007). A very aggressive plant, a prolific seed producer, grows rapidly, particularly in the first years of its life, and can reach up to 20 m. The trunk is grey, smooth in young trees but coarse-grained on mature ones. It has pinnate leaves of 30-90 cm long, with 10-40 lanceolate to oblong leaflets, 3-14 cm long and 25-50 mm wide. Most leaflets have one to three coarse teeth near their base, and 2-4 glands are located undersides the leaflet that emit a stinky odor. The flowers occur in panicles about 60 cm long at the ends of branches, and the male flowers produce a strong odor. Seeds are centered in a papery sheath called a samara, and viable in the ground for only one year. *A. altissima* grows in areas that receive more than 500 mm of annual precipitation, in most types of soils. The root system is aggressive, well developed both vertically and horizontally. The species reproduces by seeds and root suckers, which can extend up to 15 m from the trunk. It is a powerful invasive plant species in Europe, Australia, Americas, Africa, and in New Zealand. The average life span of *A. altissima* is about 100 years.

Pathway: *A. altissima* is an ornamental tree that was introduced in historical Palestine, presumably, in the 1920s during the British mandate. The tree was planted intensively in urban gardens, roadside, streets, and avenues until the 1980s, because it grows extremely fast (Dafour-dror, 2012). In Palestine, *A. altissima* was brought by private and governmental nurseries from nearby countries, and the Ministry of Agriculture, municipalities and local communities planted this species.

Vector: Most probably seeds are dispersed long distances from the parent plant by wind, water run-off, and road traffic as a secondary dispersal mechanism (Kowarik and Lippe, 2006, 2011; Kaproth and McGraw, 2008; Säumel and Kowarik, 2010), taking into consideration that mature trees can produce up to one million seeds annually (Kowarik and Säumel, 2008). In addition, root suckers might play a major role in spreading the species as they can reach a distance of about 15 m from the trunk.

Distribution: *A. altissima* is distributed in open areas, along roadsides, and cemeteries, within the Mediterranean and semi-arid region. The species was documented in a few places in central Bethlehem, east Jerusalem on the main road between Bethlehem and Hizma, few individuals in Abud village west north of Ramallah district. *A. altissima* was also documented in few sites in west central Nablus city, on the main road near Bayt Wazan. In Hebron district, few individuals were recorded near the main road in Ithna city. The species is considered invasive in Palestine.

Control and eradication

Physical control by cutting or burning the trees are ineffective approaches to control or eradicate *A. altissima.* This approach could be effective only when the roots are removed completely. This plant species has the ability to regenerate from stumps and to develop many root suckers after cutting (Colette Meloche & Stephen D. Murphy, 2006). Therefore, felling the trees is not effective and may even be counter-productive. Some studies suggest that grazing in infected sites with young *A. altissima* might suppress the plant's populations, serving as temporary solution.

Chemical control was found to be an effective approach through drill-fill treatments with broad-spectrum glyphosate-based herbicide and stem injection treatment with undiluted Imazapyr herbicide, where 90% and 95 % of trees destroyed, respectively (Meloche & Murphy, 2006, DiTomaso & Kyser, 2007). In our region, drill-fill treatment with undiluted glyphosate was the choice of treatment, since it is biodegradable, and breaks down into harmless components upon contact with soil. Glyphosate herbicide treatment is applied in the late growing season while the plant is translocating nutrients to its roots, to ensure the herbicide reaches the entire root system (Anan, 2002).

Potential threats: *A. altissima* forms dense thickets that displace native vegetation, including woody species due to the shade created by its dense foliage by the end of spring. Young trees grow rapidly therefore out-competing many native plant species for light and space (Westbrooks, 1998). *A. altissima* produces a toxin in the bark and leaves accumulate in the soil preventing native species from germination, and inhibits the growth of other native plant species (Anon., 2002, Motard *et al*., 2011, Gómez-Aparicio *et al*., 2008, Novak et al., 2018). The released chemicals prevent germination of native species within a 5-m radius around the tree (Lawrence, G. et al 1991). *A. altissima* is very allergenic, particularly to people who suffer from asthma, as well as rhinitis and conjunctivitis (Ballero, M. et al.2003).

6.3 *Conyza bonariensis* (Flax Leaved Fleabane) & *Conyza albida* (Tall Fleabane)

Family: Compositae (Asteraceae)

Conyza bonariensis on the left and *Conyza albida* on the right

Brief description: *Conyza bonariensis* is probably native to the temperate parts of South America, first described from Argentina (Michael, 1977), while *C. albida* native to sub-tropical South America. *C. bonariensis* is an erect annual with one or more stems from a basal rosette (Thebaud & Abbott 1995; Pruski & Sancho 2006). while *C. albida* is an erect annual or short-lived perennial. *C. bonariensis* has one or more stems from a basal rosette, reaching 40- 70 cm in height, unlike *C. albida* that has one central stalk and can reach up to 1.5-2 m in height. All parts of both species are greyish to green in color, covered with soft hairs, and the leaves are linear to lanceolate with the more pointed end at the base. *C. bonariensis* has narrower leaves 6 mm wide, unlike *C. Albida* that has wider leaves ranging from 7-20 mm. The inflorescence of both species is located at the top of the branches and containing white tubular flowers. *Conyza albida* has a smaller head ranging from 2-5 mm across while *C. bonariensis* has a larger head ranging between 7-9 mm wide. In our region, *C. bonariensis* and *C. albida* bloom from July to November. Both species are considered two of the most invasive and widespread weeds in modern-day agriculture (Bajwa et al. 2016). *C. bonariensis* has been introduced and naturalized in most warmer regions of Europe (Central Europe), Africa, Asia, Mediterranean Basin, the Caribbean and Central America, while *C. albida* in North America, Europe, Africa, Asia, Mediterranean Basin, and Australia (Michael, 1977, Zambrano-Navea et al.,2013). In our region, both species of *Conyza* bloom between July and November.

Pathway: There is no specific information on the introduction of both species to our region, but *C. bonariensis* was first recorded in historical Palestine in 1896, whereas *C. albida* was first recorded in 1957 (Dafni, A. and Heller, D., 1982).

Vector: Both species produce substantial amounts of small seeds (1mm). The seeds dispersed mainly by winds for tens of meters from the reproductive plant, however, a small portion of

the seeds can disperse for a larger distance reaching tens of kilometers. The seeds of *C. bonariensis* endure dormancy period of 2-3 years (Karlsson, L. M., and Per Milberg, 2007).

Distribution: Both species are located mainly in the Mediterranean zone and transition area (semi-arid) in the northern parts of the West Bank, in the cities along roadside, irrigated agricultural fields, nurseries and the surrounding areas. *C. albida* was documented in east of Nablus area along Fara' stream within the agricultural areas that extend from Alnassaryeh area to road 90 in the Jordan Valley, east of Tammoun within the agricultural area, close to Atuf in east Tubas district. It is also located in the west central Nablus area on the main road between northwestern Balata camp to Beit Iba, as well as along the main road between Bayta, Huwwara and southern part of Balata camp. In addition, the species was found between Azun Atme, Snairiya, and Al-Mudawwar area in Qalqilya District. It is also recorded on the roadsides between Fari'a camp and Siris village north of Nablus district. In Jenin district, it was documented in several places along the western part of Wadi Massin, near Zeita, and in several location at the roadsides between Al-Shuhada and Jenin city. In addition, *C. albida* is located within the agricultural field in Marj Ibn Amer in Jenin district. *C. bonariensis* is documented in few places in Palestine, its distribution is limited to specific sites, including the area between Snairiya, Azun Atme, and Al-Mudawwar, west south of Qalqilya district, in a single site to east of Faru'n area, and on the roadside to the east of Al-bathan. *C. albida* and *C. bonariensis* are considered invasive plant species in Palestine.

Control and eradication

Physical treatment: Manual removal of *C. albida*, and *C. bonariensis* is found to be the most effective treatment against both species, as young and mature plants are easy to uproot. On the other hand, mowing might have opposite results since it encourages the plant's renewal and branching. Inter-row cultivation can assist in controlling smaller plants, but is not effective for large ones.

Chemical control: Chemical control is considered effective if the herbicide (glyphosate) is used in early stages of plant development, at the rosette stage, before the central stem develops, taking into considerations that *C. bonariensis* has developed herbicides resistance in the early 2000s. No herbicide is effective in controlling *C. bonariensis*.

Potential threats: It is a weed that displaces mainly herbaceous native species (shade in dense stands) and competes with species for soil, water, and nutrients. *C. bonariensis* usually prefers undisturbed habitats, therefore is a problem in perennial crops. The weed competes for nutrients and water, combined with high resistance to herbicides, makes it a real threat in crop production regions.

6.4 *Conyza canadensis* (Canadian Horseweed)

Family: Compositae (Asteraceae)

Brief description: *Conyza canadensis* is an annual herbaceous weed native throughout most of North and Central America. It is an erect annual species with a long taproot and usually one stem arises from a basal rosette, reaching height of 1 to 2 m. Leaves are narrow and linear, up to 10 cm long and about 1 cm wide (usually 6 cm) with very few shallow teeth, clear light green. The upper part of the plant holds up lots of inflorescences at the head of the plant, each with 50 whitish-pink ray flowers. Seeds are 1 to1.3 mm long with 10-25 off-white pappus hairs, 2-4 mm long (Holm et al., 1997). In our region, *C. canadensis* blooms between July and November.

Pathway: The species was first recorded in historical Palestine in 1939 in the upper Galilee area, most probably the seeds were accidentally introduced within fish food. Another possibility is that seeds dispersed by air from nearby countries.

Vector: *C. canadensis* produces an immense number of seeds, ranging from 130,000 up to 250,000 seeds per plant (Holm et al., 1997; Weaver, 2001). The seeds are very small, mainly dispersed by wind (e.g., Ohtsuka, 1998). Dispersal process is facilitated by two factors; seeds are light in weight moreover seeds are accompanied by a pappus that aids inflight. The majority of seeds are dispersed up to 900 m from the parent plants, but in some cases, seeds can be dispersed up to 500 km. Seeds can also be spread by irrigation water (Holm et al., 1997). Some agricultural practices can encourage its spread such as mowing along roadsides, and later tillage especially during seed production. In addition, a weed in nurseries, *C. canadensis* may be spread as seed or young plants present in the soil in pots or other planting containers that accompany nursery stock, either as ornamentals (Gallitano and Skroch, 1993) or for establishing forest plantations (Prach et al., 1995).

Distribution: In General, *C. canadensis* invades roadsides, gardens, cultivated fields, and in some cases natural sites within the Mediterranean region. It also invades nature reserves and protected areas. The species was located in few sites mainly in Qalqylia District to the west of Kafr Thulth, and the central parts of Wadi Al-Qilt nature reserve.

Control and eradication

Physical treatment: traditional farming by using tillage, hand-weeding, and manual removal of *C. canadensis* during is found to be the most effective treatment, since young and mature plants are easily uprooted. Another suggested method of controlling *C. canadensis* in large-scale agricultural lands is by introducing living mulches *Trifolium subterraneum* (Enache and Ilnicki, 1988), which will minimize weed spread.

Chemical control: this species is reported to be susceptible to most herbicides including glyphosate since 1990s. However, using chemical herbicides is effective if applied during the early stages of plant development, at the rosette stage before the development of the central stem. Some studies showed that the presence of *C. canadensis* have significant effects on the soil carbon: nitrogen ratio (Chen et al., 2004), but no studies examined the effect of this change on native plant or agricultural crops.

Potential threats: *C. canadensis* was found to displace native species, mainly herbaceous plants in densely infested sites, which create shade that inhibits the development and growth of native species. It also was found to compete with other plant species (e.g., fruit tree groves) for available water, which delays the development and growth of young trees. This also might apply for native plant species. *C. canadensis* has strong allelopathic properties, which reduces or inhibits the growth of other plant native plant species or reduces their abundance and cover in infested sites.

6.5 *Datura stramonium* (Common Thornapple, Jimsonweed)

Family: Solanaceae

Brief description: *Datura stramonium* is an annual herb most probably native to Central America or tropical South America. It is a large weed, branching annual, and can reach height of 1.5 m. *D. stramonium* leaves are simple and soft, oblong or triangular in shape, 5-20 cm long and 4-15 cm wide. The upper surface of the leaves is a darker green, and the bottom parts are light green. The leaf blade is irregularly lobed and its margin is unevenly serrated. Flowers are large, up to 20 cm long, trumpet-shaped, white to creamy or sometimes violet in color. The

flower grows on short stems from either the axils of the leaves or the places where the branches fork, has five fused petals, and closes at night. The plant has egg-shaped seed capsule, 3 to 8 cm in diameter, either covered with short spines or bald (15 mm), and can hold between 600 to 700 seed, and each individual plant can produce about 30,000 seeds. In our region, *D. stramonium* blooms between June and October. The typical habitat of the species is riverbanks, streams, wadis, and other moist waste habitats. *D. stramonium* is considered as an invasive species throughout Europe, warmer regions of North, Central and South America Asia, Africa, and in the Mediterranean Basin (Weaver, et al. 1984, Gaire, 2008).

Pathway: *D. stramonium* was first documented in historical Palestine during 1912, which was found growing in several locations near dumping sites and waste areas in the north (Dafni, et al. 1982). However, there is no information on how it was introduced; some suggest that the species was used in traditional medicine to treat malaria.

Vector: Mature seeds are dispersed by dehiscence, splitting open when ripe to release the numerous seeds, and dispersed freely for a distance between of 1-3 m (Conklin, 1976). This process is assisted when plants are disturbed by harvesting equipment, where seeds are spread for longer distances. Various bird species are known to eat the seeds of *D. stramonium,* thereby acting as a dispersal agent for the seeds (Gaire, 2008). In addition, various species of beetles and ants are thought to aid in spreading of *D. stramonium.* The dispersal mechanism of *D. stramonium's* seeds by animals was not studied in our region. Running water is another possible dispersal mechanism of *D. stramonium, s*ince its preferential habitats include riverbanks, streams, and wadis.

Distribution: *D. stramonium* is mainly growing along streams, Wadis, roadside, irrigated agricultural fields, and sites of wastewater in the Mediterranean region. It is found in western part of Wadi Qana nature reserve, Azun Atme, on the roadside between Jayus and Kafr Jamal, on the roadside between Al-Ra's and Far'un between Qalqiliya and Tulkarem. It is also recorded in two places near Ain Fari'a and along the stream, within the agricultural areas in the eastern northern part of Nablus districts, as well as on the main road to Siris. In addition, *D. stramonium* was located in arid regions such as Wadi Kidron and the eastern parts of Wadi Almiqulique. The species is considered as invasive plant species, even though its distribution is limited.

Control and eradication

Physical control: Manual removal of young plants by uprooting of *D. stramonium* before they set seed is an effective approach, mainly for isolated plants, but mature ones are more difficult to control (eradicate) by uproot, because their stems become woody and roots may not be completely damaged. Larger areas of infestation (e.g, agricultural fields) might be controlled by tillage when weeds are still in the seedling stage. Seedlings possibly emerge over a long period of time; therefore, repeated cultivations may be necessary to reduce the level of infestation (Parsons and Cuthbertson, 1992).

Chemical control: This plant species is found to be susceptible to a range of soil- and foliar-applied herbicides used for selective broadleaf annual weed control. However, the use of either 2,4-Dichlorophenoxyacetic acid (2,4-D) or glyphosate is effective against young plants

(seedling and young growth stages), but both herbicides are problematic to be used near water resources (Dufour-Dror 2013).

Potential threats: The shade caused by dense stands and large leaves displaces native species that cannot compete with *D. stramonium*. The species also possesses allelopathic properties, the seed coat release chemical compounds that inhibit germination and growth of other native plant species (Nenad et al. 2018). Moreover, this species is a host for several pests and pathogen, and is susceptible to host more than 60 viruses. In addition, *D. stramonium* produces Tropane alkaloids that are poisons to human, horses, cattle, sheep, pigs, and chicken (Watt and Breyer-Brandwijk, 1962, Alexander, *et al.* 2008).

6.6 *Melia azedarach* (Chinaberry tree)

Family: Meliaceae

Brief description: The natural distribution of *Melia azedarach* is uncertain but it is thought to be native to Asia (Troup, 1921; National Academy of Sciences, 1983). However, the species has long been cultivated throughout the Middle East, the Indian subcontinent and China (Mabberley et al. 1995). It is a broad leave tree reaching between 5-12 m high, growing in moist habitats such as streambanks and wadis, edge of irrigated fields, gardens and roadsides. The bark is gray to brown and smooth in young trees, thick and longitudinally furrowed in mature ones. Small Branches are reddish with purple spots. Leaves are large, dark green, between 20-50 cm long, bipinnate, wholly or partly tripinnate, with 4-6 leaflet pairs. The leaflets are subdivided into 3-6 secondary leaflets, 5 cm long and 2.5 cm wide. Its inflorescence is a multi-flower panicle, with lilac flowers. The fruit is a pale-yellow drupe, 1-1.5 cm across, with skin that wrinkles as it ripens. The mature fruit is a pale-yellow drupe 2-4 cm by 1-2 cm, containing up to 6 elongated seeds in a hard endocarp and surrounded by a thin, succulent outer flesh that wrinkles as it ripens. The length of the seeds is between 8 to 10 mm, while the seeds

width is between 6-7 mm. *M. azedarach* is a fast-growing tree, that survives in most soil types and is resistant to high temperatures and aridity. It reproduces from both seeds and root suckers. In our region, *M. azedarach* bloom between April and May.

Pathway: the first records of *M. azedarach* in historical Palestine goes back to the 16th century, while the British reported the tree as a common garden species in the early 20th century. Several products were produced from the tree's fruit and seeds including insect repellant, oil and in folk medicine. This might be the reason behind introducing the tree into our region several hundred years ago.

Vectors: the tree produces enormous number of seeds, and several mammals and birds are known to feed on them. In our region, fruit bats (*Rousettus aegyptiacus*) are considered the main natural seed dispersal of *M. azedarach.* Probably seeds are dispersed by other mammals as well. Avian vectors are known to disperse the seed of this tree species. In addition, seedlings are able to establish below the canopy of the parent plant (Brown and Gubb, 1986).

Distribution: The species is located in several disturbed and wet habitats, edge of irrigated fields, gardens, and along roadsides, in small numbers within the Mediterranean and semi-arid zone. It is documented in small numbers in northeast Taluza and Wadi Fari'a-Al-Nassaryeh area in Nablus district, the main road between Sir and Zababida in Jenin district, and Bayt Lid east south of Tulkarem district.

Control and eradication

Physical treatment: Seedings and young plants can be removed manually by uprooting Weber (2003), whereas cutting mature trees or uprooting them is not effective since trees can regenerate from the stump and root suckers.

Chemical treatment: Using herbicides was found to be an effective method to control *M. azderach* via using the cut-stamp method with glyphosate or triclopyr (25% solution) or drill-fill techniques with triclopyr. Foliar applications using triclopyr is found to be effective but very costly (Anon., 2001).

Potential threats: *M. azedarach* is a fast-growing tree, form thick monospecific stands that prevents the regeneration of native plant species and displacing native vegetation (Weber, 2003). The species is prolific seed producer, its flowers cause irritation, while the leaves, bark, flowers and fruit are poisonous (Henderson, 2001), however, not all trees produce toxic fruits (Anderson, 1993). This species is also reported to alter soil composition by increasing its pH and adding mineralized nitrogen.

6.7 *Nicotiana glauca* (Tree Tobacco)

Family: Solanaceae


Brief description*: Nicotiana glauca* is a fast-growing perennial shrub or small tree that has smooth stems and leaves, with many branches, and is native to South America; central northwest Argentina and Bolivia (Mizrachi et al., 2000). The leaves are on stalks, bluish-green and covered with a thick epicuticular waxy layer. *N glauca* is an alternate-leaved plant, the leaves are elliptical or oval, and are 5-25 cm long. The largest leaves can reach up to 12 cm in width. The tree has tubular yellow flowers, 30-40 mm long, and are in branched clusters (panicles) at the tips of lateral branches that hang down. Fruits are egg-shaped in the form of a two-valved capsule, ranging between 7-10 mm in length, and contains many seeds. *Nicotiana glauca* grows vigorously up to 5 m in height, and produces between 10,000–1,000,000 seeds (Florentine, *et al*.2006). *N. glauca* advances in open and disturbed habitats including roadsides, dumping areas, wastelands and construction sites, while in natural areas, it is found along streams and wadis with deep soil and high humidity. In arid areas, its distribution is limited to moist habitats within streambeds, wadis, and wastewater treatment sites. *N. glauca* blooms within a year of germination, and in our region, the blooming occurs between June and September.

Pathway: *N. glauca* was reported in historical Palestine in 1898 for the first time, but no documentation on how it was introduced. Most probably, it was brought in by seed mixtures (fodder for animal) or to be used in traditional medicine.

Vector: The most effective mode of long-distance seed dispersal of *N. glauca* is through hydrochory-passive dispersal by water (Florentine, 2005), while wind might play a secondary role. Within its native and invasion range, *N. glauca* is pollinated by several bird species (Hummingbirds and Sunbirds species). However, there is not any documentation if the Palestine Sunbird or other local birds' species are involved in the process.

Distribution: *N. glauca* inhabits Wadis, stream, dumping sites, roadside and other moist habitats within the Mediterranean zone and to lesser extend the semi-arid areas. The species

was recorded from central Nablus city along the main road and Nablus stream to the west all the way to Tulkarem city. The densely populated area along this stream is concentrated from Dayr Sharaf along road 60 to Ramin, Anabta, until Nur Al-Shams camp. It is also documented at the agricultural fields within Iktaba and Tulkarem city. The species also extend to the eastern parts of Nablus, on the main road and Tuffah stream, close to Izmut village all the way to Al-Bathan area, and a long Wadi Fari'a stream and the agricultural areas of Al-Nassaryeh. *N. glauca* was also recorded near Al Hamara and Furush Beit Dajan and Al Jiffltik area along Wadi Fari'a stream all the way to road 90, in the Jordan Valley. Along the Jordan Valley, the species was recorded in small numbers within Al Uja village close to the main road. *N. glauca R. communis* were recorded south of Tulkarem, on the main road between Kafr Sur and Far'un, as well as west of Wadi Qana nature reserve, on the main road between Saniriya and abu Salem, in Azun Atme, and on the roadsides between Kafr Thulth and Azun. In addition, *R. communis* was documented in several places on the main road between Beit Sahour to Hizma, in east of Bethlehem and East Jerusalem area. The species is invasive in Palestine.

Control and eradication

Physical treatment: manual removal by uprooting young individuals is an effective approach, but for mature and larger plants, uprooting trees need special equipment such as weed wrench extractor.

Chemical treatments: using herbicides is an effective approach for mature trees, by chopping and spraying the tree with glyphosate, but repeated treatments might be needed (DiTomaso et al., 2013).

Potential threats: *N. glauca* may inhibit seeds germination of native plant species, because of its allelopathic traits (Florentine, et al.2006), while mature trees can develop dense stands due to its large leaves, which create shade that might displace native plants. *N. glauca* is highly toxic to humans and other mammals (Mizrachi et al., 2000, Panter et al., 2000). T), as it contains Anabasine, which is a similar compound to nicotine, however, when it is consumed in large doses can cause respiratory paralysis or death (Botha, et al, 2011). Some studies showed that *N. glauca* is also a potential reservoir of viruses for cultivated crop plants such as cucumber mosaic virus, tobacco mosaic virus, potato virus Y, tomato infectious chlorosis virus ((Aviña-Padilla et al., 2008, (Jones, 2001), which might cause large economic loss to the agriculture sector.

6.8 *Oxalis pes-caprae* (Bermuda Buttercup)

Family**:** Oxalidaceae

Brief description*: Oxalis pes-caprae* is a small, bulbous perennial herb, reaching a height of 15-30 cm, native to to the Cape Region of South Africa (Holm et al, 1991). The plant's shoots ascend from a short vertical stem, attached to a pale brown underground bulb, and each bulb is capable of producing over 20 small whitish bulblets each year (Peirce, 1997). Its leaves are composed of three cordate leaflets with black dots on their upper side, petioles are 10-15 cm long, and leaves fold backwards during the night. Flowers of *O. pes-caprae* are bright yellow, arranged in umbel-like inflorescences, generally having fewer than 20 flowers each, with peduncles shorter than 30 cm in height (Parsons and Cuthbertson, 1992, Peirce, 1997). The flowers have five petals fused at their base, which open in the daytime and close at night.

Pathway: *O. pes-caprae* was imported into Sicily and then to Europe in 1796 as an ornamental plant and became an invasive species. Thereafter it was brought to the Middle East (Castro et al, 2013, Castro et al, 2016), and to historical Palestine around 1906.

Vector: In our region, *O. pes-caprae* reproduces exclusively asexually through bulblets formed from rhizomes (Castro et al, 2016). Therefore, bulblets could be dispersed by cultivation and agricultural practices, transporting contaminated soils or garden refuse, or by earthmoving equipment. In addition, bulbs and bulblets can be moved by soil disturbance, wind, vehicles, water (bulbs and bulblets can flow), birds, and wild boars for short distances (Brooks 2001).

Distribution: *O. pes-caprae* is mainly distributed in the Mediterranean zone and to a lesser extent in areas that receive between 250 to 350 mm of precipitation (Irano-Turanian). The species was recorded in few places west of Nablus on the main road between Bayt Wazan and Sarra, one site in the eastern part of Wadi Qana nature reserves, and one site west of Ramallah on the main road to Baitunya town. The species has a high potential of being an invasive species in the near future, if no actions are taken to prevent its spread.

Control and eradication

Mechanical treatment: Small-infested areas can be treated by repeated manual removal of the entire plant, rhizomes and bulblets by digging around the plant to be removed (Gluesenkamp, 2002). However, this method is extremely time and labor intensive. Moreover, the soil of the uprooted plants, should also be cautiously inspected or sieved to remove all bulbs and bulblets.

Chemical treatment: using herbicides (e.g., 2% solution of glyphosate) to control *O. pes-caprae* is very effective, but does not kill all plants. Chemical treatments should be applied before the flowering season (November) and repeated treatments might be needed, because new plants are able to germinate from bulblets and mature very rapidly (Mike Kelly (2002).

Potential threats: Displacement of native geophytes and annuals species, and reduction of plant species richness, are the most documented effects of *O. pes-caprae* as it creates dens carpets and compete with native species on space, water, and resources, which prevents the establishment of other herbaceous species ((Brooks 2001, Petsikos et al.2007). *O.s pes-caprae* might cause oxalate poisoning to livestock if eaten in large quantities (Hulme PE. 2004).

6.9 *Parkinsonia aculeata* (Horse Bean, Jerusalem Thorn)

Family*:* *Fabaceae*

Brief description*: Parkinsonia aculeata* is an evergreen shrubby tree, reaching 2-6 meters in height, and is native to the Americas, especially in the hot and dry regions of south USA, Mexico, and Center America (Hawkins et al., 2007). The trunk is fissured, black-brown in color, branching near the ground, and the branches are crocked greenish, having thorns up to 3 cm long. *P. aculeata* leaves are bi-pinnate, 20-40 cm long, with small-elongated leaflets, 4-10 cm long. Flowers have five yellow petals, clawed banner petal are 9-13 mm long, flecked with orange, turning deep orange-brown and folding forwards post-pollination. Fruits indehiscent, orange-brown glabrous pods, 3-6 cm long, sometimes reaching 13 cm, and 7 mm wide, subterete, constricted and flattened between seeds. Each pod contains 2-8 seeds ranging in size from 8 to 11 mm long, 3-4 mm wide, and they are olive or green in color. *P. aculeata* is a very

rapidly growing tree, known for its ability to tolerate the driest and most saline sites and waterlogging, growing in diverse soil types, very basic and very acidic (Parsons and Cuthbertson, 1991, Luna 1996). Propagation of *P. aculeata* is generally by seeds, mature trees can produce about 5,000 seeds annually (Parsons and Cuthbertson, 1991). Propagation is also reported by (root or shoot) cuttings or air-layering (Singh, 1989), and regenerates after fire or cutting. In our region, *P. aculeata* blooms between April and early autumn. In historical Palestine, *P. aculeata* became an invasive species in the 1970s.

Pathway: *P. aculeata* tree was introduced to historical Palestine during the Ottoman period, and was documented by the British in 1922, describing it as a sub-spontaneous tree. One of the main reasons of its introduction was for afforestation purposes in sandy and arid habitats, but also as an ornamental tree, hedging, and fodder.

Vector: *P. aculeata* pods fall close to the parent plant, but can float on water, which seems to be the main natural dispersal mechanism. Pods have limited nutritional value and in general are not palatable by mammals. Therefore, the pods are not adapted to dispersal by herbivores (Klinken, et al.2009). However, seeds might be dispersed in mud sticking to animals and machinery (Klinken, et al.2009). Birds might also play a role in dispersing the seeds of *P. aculeata.* In addition, the seeds exhibit deep dormancy, so they are very long-lived (Klinken et al., 2008).

Distribution: *P. aculeata* mainly inhabits roadside and gardens, recorded in few places in Palestine including two sites along the roadside between Furush Beit Dajan and Far'a El Giftlik that lead to the Jordan Valley (Road 90). It is also located in two sites in the western part of Falame village, in Qalqiliya district. Local communities planted most of located trees. The species is an invasive plant in Palestine; but no evidence of germination or natural reproduction or establishment.

Control and eradication

Physical treatment: seedlings and juveniles of *P. aculeata* can be uprooted or hand pulled, but mature and larger plants are uprooted by bulldozing, pulling with a tractor or grubbing gives effective control (Starr et al., 2003). This approach is effective but must be followed by a seedling growth control (Parsons and Cuthbertson, 1992)

Chemical control: *P. aculeata* can be controlled chemically by drill-fill or cut stump methods with 2,4-D combined with Triclopyr. Mature trees can also be controlled with basal bark treatment, using Picloram + 2,4-D or triclopyr (Parsons and Cuthbertson, 1992). Another effective method is using Hexazinone herbicide, which can be used by applying the chemical to the soil surface near the base of the stems just before rain; therefore, Hexazinone is washed away into the soil and kills *P. aculeata*.

Potential threats: *P. aculeata* grows rapidly and branches near the ground forming dense groves, which creates heavy shades that displaces almost all native species and prevents access for humans, native animals and livestock.

6.10 *Prosopis juliflora* (Mesquite)

Family: *Fabaceae*

Brief description: *Prosopis juliflora* is an evergreen tree, native to Mexico, central and northern South America. The genus *Prosopis* is treated as one of the world's worst invasive plant species, and *P. juliflora* is by far the most invasive species. *P. juliflora* tree can reach up to 12 m height (3-12), with a broad flat canopy; dropping branches give it a shrub-like appearance, somewhat spiny with persistent, green foliage, the woody thorns are up to 5-cm long. Leaves are bipinnate, ranging in length from 6 to 8 cm, glabrous, containing 1-3 pairs of pinnae and 12-20 paired leaflets. The leaflets are oblong, 5-12 mm long and 1.5-2.5 mm wide, with rounded tips, glabrous upper sides and slightly hairy undersides. Its flowers are tiny, yellowish to greenish in color, borne on a 10 cm long tubular raceme. The fruit is a brown pod with 10-20 oblong seeds, up to7 mm long and 2-5 mm wide. *P. juliflora is* adapted to arid and semi-arid climates, surviving extreme soil salinity (Patnaik et al., 2017). The tree has two root systems, a deep taproot that reach a depth of 15-20 m and surface lateral roots to make use of infrequent rainfall events. *P. juliflora* reproduces by both seeds and vegetatively by root cuttings. The tree produces enormous number of seeds, about 2000 seeds/m^2 were measured in a study. *P. juliflora* usually begins to flower and fruit after 2-4 years, sometimes later. In our region, *P. juliflora* blooms between April and October.

Pathway: *P. juliflora* was first introduced to historical Palestine in the 1960s, by the Forestry Department of the Jewish National fund organization (Dufour-Dror, and Shmida, 2017). *P. juliflora* was planted in the arid and semi-arid areas for ornamental and environmental purposes, an action that continued until 2012.

Vector: *P. juliflora's* fruits are consumed by livestock (goats, sheep, and cattle or camels), and by wild animals, therefore act as dispersal agents through faeces (Pasiecznik et al., 2001). Digested seeds in faeces have better germination rate (Peinetti et al, 1993). Birds, bats, and reptiles also feed on *P. juliflora* fruits but are considered as minor dispersal agents. Water is an important dispersal agent of *P. juliflora* in desert ecosystems, during flooding or other high rainfall events when seedling establishment is favored.

Distribution: *P. juliflora* is only recorded in two areas along the central part of the Jordan valley. The first location is a small patch of about 20 hectares near Fasayel village, to the east of Fasayel nature reserve within the boundaries of the Central Ghor Region KBA. The site was planted by the Israeli Jewish National Fund, probably 30 years ago with couple of dozens of *P. juliflora.* The second documented site of *P. juliflora* is within the Auja area to the west of road 90. The species is considered as an invasive species in Palestine with very limited establishment and distribution.

Control and eradication

Physical treatment: Hand clearance of young and seedlings of *P. juliflora is* effective, especially in small high value lands such as agricultural fields. Heavy machinery is needed for uprooting large trees. Cutting the trees alone is ineffective since it will stimulate the development of root suckers.

Chemical treatment: Spraying the leaves with herbicides is found to be ineffective. Cut-stump method using Triclopyr was found to be effective.

Potential threats: The main potential threat of *P. juliflora* to natural sites in Palestine is displacing native trees and decreasing species richness (Kaur et al., 2012). The tree is known to inhibit germination of other seed plant species lying in its surrounding (El-Keblawy & Al-Rawai 2007; 2014). The streams with permanent water in the Dead Sea Valley are particularly threatened by *P. juliflora* replacing rare native plant species (Shmida et al 2011). In addition, *P. juliflora* has strong and poisonous thorns, which could cause serious inflammation that might take days (few weeks) to heal (Dubow 2011; Walter & Armstrong 2014). *P. juliflora* is known for its allergenic nature, which might trigger allergic asthma, rhinitis, and skin allergy (AlFrayh et al. 1999, Dousti et al. 2016).

6.11 *Ricinus communis* (Castor bean, Castor Oil Plant)

Family: *Euphorbiaceae*

Brief description: *Ricinus communis* is a dioecious shrub or small tree that can grow from 1 to 4.5 m, with a strong tap-root and prominent lateral roots. It is native to the tropical Africa and Asia (Weiss, 2000). *R. communis* branches from its base, having very large palmate simple leaves, spirally arranged, getting dark green when old, and 10-40 cm width. The alternate leaves are a glossy dark green, occasionally with red veins. The trunk is smooth and reddish. The flowers are monoecious, arranged in a 10-30 cm long panicle (Institute of Pacific Islands Forestry, 2002), capable of self- and cross-pollination. The minute male flowers are yellowish to greenish and their stamens have branched filaments. The female flowers are located above the male flowers and have three red pistils. The fruit is oblong, 10-20 mm long, covered in soft spines and contains two bean-like, brown seeds with black spots that are 9-22 mm long and 3-4 mm wide. *R. communis* grows rapidly, might reach 2 m height within a year in moist habitats (Dafour-Dror 2012). The shrub adapts quickly to different environments, produces an enormous number of toxic seeds, and propagation is only by seeds.

Pathway: The tree was introduced to Egypt 6000 years ago for oil production, then spread to the Mediterranean and Middle East region (Deacon 1986). There is no evidence when the plant was introduced to historical Palestine, but was mentioned in ancient books. In our region, it was used for oil production and in medicine as a purgative. However, the first recent documentation of *R. communis* in historical Palestine goes back to 1894.

Vector: Gravity disperses seeds from the pods when the ripe pods explode open (Institute of Pacific Islands Forestry, 2002). *R. communis* seeds can be dispersed by runoff, floodwater, and on mud adhering to boots, on vehicles and machinery, on animals, and through transporting infested soil (Dafour-Dror 2012). The seeds are dispersed also by ants (Martins et al., 2006, 2011), birds, rodents, and other mammals (Cronk and Fuller, 1995; Weber, 2003),

Distribution*: R. communis* inhabits Wadis, stream, dumping sites, roadside and other moist habitats within the Mediterranean zone and to a lesser extent semi-arid area. The species was recorded from central Nablus city along the main road and Nablus stream to the west all the way to Tulkarem city. The densely populated area along this stream is concentrated from Dayr Sharaf along road 60 to Ramin, Anabta, until Nur Al-Shams camp. It is also documented in the agricultural fields within Iktaba and Tulkarem city. The species also extend to the eastern parts of Nablus, on the main road and Tuffah stream, close to Izmut village all the way to Al-Bathan area, and along Wadi Fari'a stream and the agricultural areas of Al-Nassaryeh. *R. communis* was also recorded near Al Hamar and Furush Beit Dajan and Al Jiffltik area along Wadi Fari'a stream all they way to road 90, in the Jordan Valley. Along the Jordan Valley, the species was recorded in small numbers within AlUja village close to the main road. *R. communis* is recorded south of Tulkarem, on the main road between Kafr Sur and Far'un, as well as west of Wadi Qana nature reserve, on the main road between Saniriya and abu Salem, in Azun Atme, and on the roadsides between Kafr Thulth and Azun. In Bethlehem and East Jurusalem area, *R. communis* was documented in several places on the main road between Beit Sahour to Hizma, Wadi Al Nar Road and in several palces along Wadi Qidron area. In Hebron, the species was documented in several places along the main road to Wadi Al Quf nature reserve to Tarqumya, as well as in the road side between Tarqumya and Idhna.

Control and eradication

Physical treatment: *R. communis* seedlings and young plants can be removed easily by hand (uprooted), but it is very important to make sure that all roots have been removed, else, specimens will regenerate.

Chemical treatment: *R. communis* can be controlled chemically by cut stump method using glyphosate (Roundup) or triclopyr (Garlon), when applied correctly. Chemical treatment is found to be more effective if herbicides are applied before the plant has set fruit (Weber, 2003).

Potential threats: *R. communis* is extremely poisonous to animals and humans, and the seeds are particularly dangerous (Henderson, 2001) and might constitute risk for children and animals. The pollen of *R. communis* might cause respiratory allergies in humans. In addition, the tree might form dense thickets, especially in moist habitats, which shade out native vegetation and displace native plant species (Weber, 2003).

6.12 *Solanum elaeagnifolium* (Silverleaf Nightshade)

Family: Solanaceae

Brief description*: Solanum elaeagnifolium* is a perennial herb, reaching up to 50 cm tall, and native to southwestern USA and northern Mexico (Eleftherohorinos et al., 1993). Vegetative growth usually annual, erect, branched above, usually armed with straight, fine, reddish prickles 2-5 mm long. Stem and leaves are covered with short dense hairs that give silvery-white hue. Its leaves are simple, alternate, lower leaves oblong-lanceolate with wavy ends, up to 10 cm long and 1-2 cm wide. Flowers perfect, actinomorphic, with diameter of 3.5 cm, each flower has 5 violet-lilac petals and 5 yellow stamens. Berries at first are marbled green, later yellow to finally orangish brown, mucilaginous, globose, 0.8-1.4 cm in diameter, and calyx covering base of fruit. Seeds are pale brown, discoid and flattened, about 3 mm long, and smooth (Wagner et al., 2014). *S. elaeagnifolium* is deep-rooted, develops both horizontal and

vertical root system, penetrates to depth of 2 m but the majority of the roots are found close to the surface within 25 cm depth. The plant is resistant to draught and cold, therefore can be found in semi-arid regions, even in saline soil. The species can reproduce by seeds, rhizomes, and root fragments. A single mature plant can produce a large number of seeds (1500-7200) that remain viable for at least ten years. In our region, *S. elaeagnifolium* bloom between May and August.

Pathway: The first record of *S. elaeagnifolium* in historical Palestine was in 1957, however, exact information on how this weed was introduced is not known, but most probably in mixed seeds for agriculture or in fodder (Dafour-dror 2012).

Vector: *S. elaeagnifolium* spreads by seeds and to a lesser extent vegetatively (Stanton et al., 2012). Livestock graze on the plant and carry some of its parts, which makes them important long-distance dispersal agents (Mekki, 2007). The seed remains viable for 2 weeks after ingestions by livestock. *S. elaeagnifolium* can also spread by agricultural equipment, wind, running water, and birds.

Distribution: *S. elaeagnifolium* inhabits the Mediterranean and semi-arid zones with wide range of precipitations (150 to 600 mm). It is located in few places along wadi Fari'a stream and the agricultural fields within Al-nassaryeh area east of Nablus district, along road 90 in the Jordan valley within Fasa'il area, and in Azun Atme in the west north of Salfit. *S. elaeagnifolium* is also located in Jenin district, in the agricultural fields near Kufr Dan, to the north of the main road as well as in Marj Ibn Amer area. In Hebron, the species was found in agricultural field to the west of Idhna area. The species is considered an invasive species in Palestine.

Control and eradication

Physical treatment: *S. elaeagnifolium* is one of the most difficult invasive plants to control and eradicate in our region. Manual removal and uprooting are not effective, since root fragments remain in the soil enabling the regeneration of the plant. However, to make the manual removal effective, the whole plant must be uprooted with a large mound of soil that includes all the root system. Then, the uprooted plant with the soil should be buried at a depth of 3 m.

Chemical treatment: Using herbicides is not effective to control and eradicate *S. elaeagnifolium*. However, using picloram, glyphosate or 2,4-D affects the foliage part of the plant but not the root system (Wassermann 1988, Heap, 1997).

Potential threats: *S. elaeagnifolium* competes with herbaceous vegetation and a variety of crops for moisture and nutrients, since it can develop large and relatively dens patches, with extensive root system that spread in the upper soil layers. The plant also acts as a host for insects and plant diseases (Boyd and Murray, 1982; Lemerle and Leys, 1991). The berries (fruits) of *S. elaeagnifolium* are toxic to livestock when eaten in large quantities, especially to sheep and goats. In addition, the herb has also been reported to exhibit allelopathic effects on several crops and native species.

6.13 *Xanthium strumarium* (Common Cocklebur, Rough Cocklebur)

Family: Asteraceae (Compositae)

Brief description*: Xanthium strumarium* is a course, erect, branching, noxious, annual weed, most probably native to North America-Western United State (Nel, 2004). The stems are 30 to 120 cm tall, with short dark streaks or spots and covered with short hairs. Its leaves are triangular-ovate to broadly ovate in shape, 4 to 12 cm long, with a long petiole (2-8 cm). The leaves' margins are irregularly toothed or lobed and both surfaces are rough- pubescent. *X. strumarium* is a monoecious plant with small green flowers. Male inflorescences are located above female ones, with a diameter of 5-8 mm. the fruit is hard brown, ovoid bur, up to 2 cm long, and they are covered with hooked spines ranging in length between 2 to 4 mm, and with two terminal beaks. *X. strumarium* fruit turns from green to yellow as they ripen, and finally to brown. The fruits are borne in clusters of up to a dozen and each one contains two brown or black seeds. *X. strumarium* inhabits mainly moist habitats, such as streams and seasonal pools, but also roadsides, field edges, cultivated fields and dumping sites. The plants root system is well-developed, and very fast growing. Mature plants in open fields can produce from 500 to 2300 burs per plant (Weaver and Lechowicz, 1983). In our region, *X. strumarium* blooms in the summer months.

Pathway: *X. strumarium* was first reported in historical Palestine in 1921 (Dafni and Heller, 1982), but there is no precise information on how it was introduced. Most probably, the seeds were imported inadvertently together with seeds intended for agriculture or fruits of the plant brought in with sheep wool from Australia or United States.

Vector: *X. strumarium* reproduces solely by seeds. The fruits are dispersed by animals which carry the fruits on their coats (Saeed et al., 2020). In addition, the fruits have air pockets, which allow them to float on the water, and spread rapidly along streams and roadsides.

Distribution: *X. strumarium* inhabit stream banks, seasonal pools, wastewater treatment pools and along roadsides. It was located in small populations at the western part of Wadi Qana and at a small stream near Bayt Amin to west north of Salfit district. The species was also located in a few places along Wadi Fari'a east of Nablus, and along the main road between Beit Iba

and Dayr Sharaf to the west of Nablus. It was also documented in several places along Wadi Al Qilt nature reserve and Wadi Al-Miqulique (Og) near the Dead Sea. The species is considered invasive in Palestine.

Control and eradication

Physical control: Seedlings and small-invaded sites of *X. strumarium* can be removed manually and uprooted, but older plants usually have shoots from axillary buds therefore this approach is ineffective for controlling or eradicating mature plants.

Chemical control: The use of herbicides is effective in controlling *X. strumarium*. Spraying the plant with 2,4-D is found to be very effective if applied before blooming. Other effective herbicides include sulcitrone, amitrole, bentazon, and fomesafen.

Potential threats: *X. strumarium* forms dense stands, which might displace native plant species that grow on banks of streams and other water bodies. The plant contains carboxyatractyloside, a toxic compound, where cattle, sheep and goats may be poisoned by eating young plants (Weaver and Lechowicz, 1982; Hocking and Liddle, 1986; Martin et al., 1992). *X. strumarium* was reported to serve as a host for a number of pathogens of crops in different countries such as *Puccinia xanthii, Alternaria helianthi, Colletotrichum capsici,* causing economical losses.

6.14 Leucaena leucocephala (Coffee bush, False koa)

Family: Fabaceae

Brief description: is a small tree reaching up to 15 m height, native to Mexico (Hughes, 2006). Its bark is mid grey-brown with shallow vertical fissures. The younger stems are green and usually densely covered in fine greyish colored hairs. Its leaves are bipinnate, up to 35 cm long, and have 3-10 pairs of pinnae. A small gland is usually present on the petiole, or just below where the lowest pair of pinnae meet. The pinnae are 2-10 cm long and each bear 5-22 pairs of leaflets, which are 7-21 mm long and 1.5-5 mm wide. The leaflets are narrowly oblong to

lanceolate in shape with pointed tips, and are either glabrous or ciliate margins. *L.leucocephala* flowers are borne in dense globular clusters and these clusters are borne in the axils on peduncles that range in length from 2 to 6 cm. Each of the small flowers has five tiny sepals, five small greenish-white colored petals, and ten prominent pale yellow or whitish colored stamens. Its fruits are elongated; the pods are with a pointed tip, initially green in color, but turn brown or reddish-brown as they mature. Each of these pods contains 10-25 hard seeds, ranging in length from 6-10 mm, and between 3-6 mm in width. *L. leucocephala* is self-fertile and produces an enormous number of seeds every year which remain viable in the soil for many years and can germinate in a short time (Gonzalez et al., 1967; Pan, 1988; Hughes, 1998). It usually inhabits disturbed and degraded habitats, roadsides, abandoned fields, waste fields, and agricultural lands. (Cronk and Fuller 1995, Geiger & Gutierrez 2000).

Pathway: There is no information on how this species was introduced to the region, however, it was listed as a naturalized species only in 2017 (Dufour-Dror & Fragman-Sapir, 2017).

Vector: *L. leucocephala* seeds are dispersed mainly by gravity, and facilitated by small animals (rodents and probably birds), livestock and ground insects (Cronk and Fuller, 1995). The light pods might spread short distances by wind and seeds can float on water. Seeds movement could be facilitated by human activity as well (Campbell et al., 2019).

Distribution: *L. leucocephala* inhabits the Mediterranean and semi-arid zones within disturbed and degraded habitats, roadsides, abandoned fields, and waste fields, agricultural and cultivated areas. It was recorded on the eastern parts of Nablus district from Ein Fari'a, along the stream and the roadside all the way to Jifftlik close to the main road in the Jordan Valley, in center part of Nablus city, in eastern parts of Al-Miksar nature reserve, and in a few places within Al Bathan area. In the Jordan valley, the species was recorded in agricultural fields in Al Auja village. *L. leucocephala* was also located on the western part of Wadi Qana nature reserve, in Saniriya and Azun village in Qalqilya district. Within Tulkarem district, the species was located in a few places in west northern Anabta and south west of Atil. In the northern parts of the West bank, the species was located in several places within Jenin, Brukin, and on the main road near Marj Ibn Amer. It was also documented in Bethlehem, Hebron, and Jerusalem districts. *L. leucocephala* is considered an invasive species in Palestine.

Control and eradication

Mechanical Control: Cutting and uprooting is an effective approach for younger plants at a localized scale, however, older plants are likely to resprout after such interventions, therefore, cutting must be followed by removing sprouts and the root mass as well. Grazing by livestock is found to be a helpful approach to control the species but not effective solely (Kuo, 2003).

Chemical control: Applying herbicide (Glyforside), to the surface of the trunk immediately after cutting down to prevent growing sprouts (Kuo,2003). Triclopyr, tebuthiuron, triclopyer, ester, as well as 2.4- D are effective treatments as well. Best results can be achieved when mechanical and chemical treatments are combined.

Potential threats: *L. leucocephala* is known to form dense thickets where other native species are outcompeted. Consequently, the diversity of native species is reduced (Weber, 2003). *L. leucocephala* has strong allelopathic potential, the leaves produce toxic chemicals that inhibit

the germination and growth of other plant species. (Kuo,2003). The species raises soil nitrogen levels with possible negative impacts on nutrient balances and cycling in invaded natural systems. In addition, *L. leucocephala* is classified as a potential habitat transformer (Henderson, 2001). Making the rehabilitation of an invaded ecosystem very difficult.

6.15 *Bidens pilosa* (BlackJack)

Family: Asteraceae

Brief description: *Bidens pilosa* is an annual and erect herb, native to the South and Central America (Hsu & Kao, 2014). The height of the plant can reach up to 1.8 m (Stanley and Ross 1983-1989), glabrous or very sparsely pubescent in upper part. Leaf blade either ovate to lanceolate, or pinnately, with 3-7 primary lobes that are ovate to lanceolate in shape, with pilosulose to sparsely hirtellous or glabrate surfaces. The inflorescence is solitary capitula or capitula in lax corymbs, and the capitula is radiate or discoid. Ray florets absent or lamina whitish to pinkish, while disk florets 20 corollas yellowish. The outer achenes are red-brown, flat, and linear to narrowly cuneate, faces obscurely 2-grooved, sometimes tuberculate-hispidulou, margin antrorsely hispidulous, apex truncate or somewhat attenuate. The inner achenes blackish, equally 4-angled, linear-fusiform. A single plant can produce 3000–6000 seeds, which remain viable up to 6 years (Bartolome et al., 2013). It is a cosmopolitan herb, considered invasive of annual and perennial crops and widely distributed in agricultural and disturbed habitat, along roadsides, and waste areas (Silva et al., 2011, Wang et al., 2017, Grombone-Guaratini et al., 2004). *B. pilosa* propagates via seeds, and self-compatible species that may reproduce by selfing or by cross-pollination. It is a fast-growing herb that starts flowering six weeks after emergence, and mature seeds are produced four weeks after flowering.

Pathway: *B. pilosa* has been introduced deliberately for agricultural, ornamental or medicinal purposes (Carlquist, 1966). In Palestine, there is no information how the species was introduced, but most probably though seed mixes for feeding for animals from the United States.

Vector: The fruits of *B. pilosa* have tiny barbed hooks or stiff bristles, which easily attaches to human clothes, feathers or fur of wild animals and livestock. It is also reported that seeds can disperse by wind or water (floods, running water).

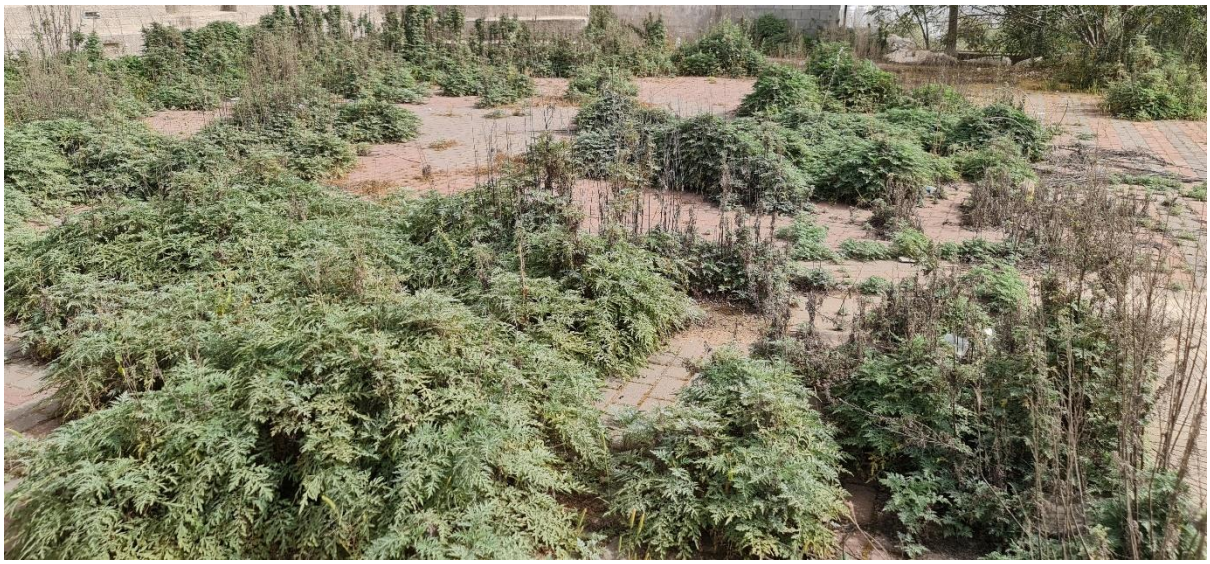
Distribution: The species was located in few locations along roadside between Fari'a camp and Siris, the main road of Wadi Al Bathan, Azun Atme and Bait Amin.

Control and eradication:
Mechanical Control: The plant can be controlled by persistent mowing, hoeing and hand pulling (uprooting), before flowering, in order to prevent seed production.
Chemical Control: The species is susceptible to several types of herbicides including broad-leafed plant herbicides. Residual translocated herbicides are found to be very effective such as glyphosate-trimesium, oxyfluorfen, atrazine, 2,4-D glyphosate, pendimethalin, metribuzin, diuron, paraquat, nicosulfuron, and simazine (EchegoyTn et al., 1996; Ferreira et al., 1996; Paulo et al., 1997; Vieira et al., 1998b; Melhoranca, 1999).

Potential threats: *B. pilosa* is a fast-growing invasive species, producing an enormous number of seeds, germinates quickly, and forms dense stands, therefore, out competes, outgrows, and eliminates crop and native plant species. The leaves and the roots of *B. pilosa* contains allelopathic material inhabiting the germination of native species, and remain active throughout decomposition. The burrs of the weed are an irritant to human and livestock, while roots, leaves and flowers are poisonous.

6.16 *Ambrosia confertiflora* (Burr Ragweed, Slimleaf Bursage)

Family: Asteraceae



Brief Description: *Ambrosia confertiflora* is a perennial herb native to northern Mexico and the southwestern United States (Dufour-Dror, 2012, EPPO 2019). It is an upright perennial herb reaching 75-250 cm tall, forming large stands from creeping runner-like roots that are part of a very dense root system concentrated in the upper soil layer extending down to a depth of

30 cm. It has grey-green, bipinnate, fern-like leaves, 12-16 cm long and 10-15 cm wide. Its grayish green leaves are 12-16 cm long and 10- 15 cm across. The leaves have short petioles divided into long lobes and their margins have sparse short hairs. The leaves are opposite at the base of the stem and alternate on the upper part of the plant. *A. confertiflora* is monoecious, with numerous small male and female flower, yellow or greenish in color. The male flowers borne on erect clusters, while female flowers lack petals and are concentrated in leaf axils in a cup-shaped involucre. Fruit is a spiny bur, pyramidal to pyriform, 1-2 mm long, strigillose to pilosulous, bearing 10-20 hooked spines, each containing a single seed 3-4 mm in diameter. (Flora of North America, 2022) *A. confertiflora* reproduces from seeds as well as vegetatively by adaptive buds found on spreading horizontal roots (Sabban et al. (2012) This species has the ability to renew themselves within five weeks of mowing. In Palestine the species blooms from September through December (mainly September to October).

Pathway: *A. confertiflora* was first recorded in Palestine in 1995, in the western part of Nablus area. The species was possibly introduced from the United States through seed mixes for feeding birds and pond fish. Also, it could have been introduced to Palestine through shipments of cattle and sheep from Australia (Dufour-Dror, 2012).

Vector: *A. confertiflora is* wind pollenated, reproduces from seeds and vegetatively. The seeds are dispersed in several ways, the fruits of the plant have hoked spines that stick to the coat of animals, or attached to clothing and footwear, therefore, the seeds are dispersed. The seeds can also be transported in mud on vehicles and machinery, and through flowing water, in streams or during floods. *A. confertiflora* can also be propagated via its perennial rhizome and thus could be spread in contaminated soil. *A. confertiflora* is one of the fastest spreading terrestrial invasive species in Palestine (EPPO 2019).

Distribution: *A. confertiflora* inhabits open area along streams, seasonally moist habitats, along roadsides, cultivated fields and even nature reserves. It was documented along Nablus stream and the main road from Beit Iba in Nablus district to the western part of Tulkarem, and from Dair Sharaf in western Nablus along the main road to Fandaqumiya all the way to Arraba Junction, and from there to Imreiha and Zibda in the western parts of Jenin district. It is also recorded on the roadsides between Al Hafira and Al Shahada town that leads to Jenin city, on the roadsides from Jaba' to Misilyah, on the road sides in Qabatya, Arraba agricultural fields (Sahel Arraba), Sanur-Meithalun agricutlrual fields (Sahel Sanur). *A. confertiflora* invaded the roadsides between Askar camp to the east of Nablus, and all the way along the main road to Wadi Al Bathan, Ein Al Far'a, Tubas, Aqaba, and Kufier in Jenin district. From the area near Ein Al far'a, the species invaded the whole stream area including agricultural fields along Wadi Far'a in an eastern direction to Khirbit Al Aqrbaniya, Furush Beit Djan, Khalet Al Fule, Far'a El Gifflik to the main road (road 90) in the Jordan Valley and the agricultural fields within Al Gifttlik area, east of road 90. It is also documented in several data palm plantations in the Jordav valley within Marj Na'jeh and Zubaydat, along the roadsides from Marj Na'jeh to Al Auja area, within Wadi Fasayel Nature reserves in the Jordan valley. Moreover, *A. confertiflora* was documented from Huwwarah Junction on the roadside all the way to to Hares and Dair Istiya, in a few places on the roadsides to Dair Ballout, on the roadsides from Al Luban El

Sharqiya to Wadi Al Haramyeh junction in Ramallah district, and on the roadsides between Hizma and Jaba'. It is also located in several places within the upper part of Wadi Al Qilt nature reserve. In Hebron district, the plant was documented along the roadsides in Beit-Ummar to Wadi Al Quff nature reserve that led to Tarqumiyah, and few places in Idhna. In addition, the plant was documented on the roadside near Al Funduq, within the town of Jinsafut, and Wadi Qana nature reserve in several places.

Control and eradication:

Mechanical control: cutting or uprooting *A. confertiflora plants* is not effective, on the contrary, it can make the infestation worse by spreading pieces of the perennial root and stimulating the development of root buds, exacerbating the intensity of the invasion as the plant regenerates very quickly after mowing. Uprooting may only be effective against very young plants, as otherwise, the root remains in the soil and the plant regenerates (EPPO, 2019).

Chemical control: Several chemical herbicides were tested in several countries to control *A. confertiflora*. Young plants were found to be moderetly resistant to the 2, 4-D, and a micture including 2, 4-D when applied to plants 15 cm high found to controll the aerial parts of *A. confertiflora* but failed to kill the rhizomes (Villar, 1959). Other herbicides such as glyphosate, triclopyr and fluroxypyr are not very effective as the plant recovers quickly after spraying. A mixture of 2,4-D and picloram (Tordon 75-D) was used in Australia and found to be efficient in controloing *A. confertiflora,* but using picloram in humid habitats (wetlands and riparian habitats) have advers effects and has been rejected to be used in some countries. Imazapyr herbicide has been found to be the most effective herbicide and provided satisfying results in controlling *A. confertiflora* in pastures (EPPO 2019, Crothers, 1993). However, these herbicides are not registered for use in wetlands and riparian habitats since they are hazardous to aquatic organisms. Some countries are working on developing a specific protocol on how to control and manage the spread of *A. confertiflora*, and which herbicide is best to use, and method of application.

6.17 *Atriplex holocarpa* (Pop Saltbush)

Family: Chenopodiaceae

Description: *Atriplex holocarpa* is an annual or short-lived perennial plant, with a hard subligneous base, native to semi-arid areas in Southern Australia. The stem is branching, diffuse or procumbent, softly scurfy-tomentose, with alternate, succulent and rhomboid leaves. The leaf margin has small, irregular lobes, and the leaf is 10-30 mm wide. Leaf color is greenish with white spots. *A. holocarpa* is monoecious, has tiny separate male and female flowers that develop in the upper leaf axils. The fruit is spherical, lemon-like and has a spongy texture. *A. holocarpa* is a halophyte and is very tolerant of saline conditions in its native range. The *A. holocarpa* seeds are capsuled in a lemon-shaped or globular spongy mass (seedcase), at maturity it turns blackish and fall to the ground. The ecological properties of the species are not well known, it grows in the desert, in clay soils, in flat areas and areas where runoff collects, such as roadsides and wadi beds.

Pathway: *A. holocarpa* was introduced to historical Palestine in the 1960s from Australia as a potential pasture plant for arid regions. It was planted in experimental plots in Negev area, and from their it spread.

Vector: *A. holocarpa* is a wind-pollinated species, its seeds are dispersed by wind and runoff along streams, wadis, and roadsides, and flooded area in the desert. There is no information if wildlife or livestock feed on the plant or its seeds.

Distribution: The species was located in a few places east of Jericho along the Dead Sea Road, near the Dead Sea Junction at the roadside, at the eastern part of Wadi Qana close to the Dead Sea shore, and in several places along the roadside to Wadi Darajeh.

Control and eradication: No information is available in littreture

Potential threats: there is not enough studies on the potential threat of *A. holocarpa* on native species, public health, or ecosystem. However, some studies indicate that the effect of the species on native plants is limited to competition on soil water.

6.18 *Xanthium spinosum* (Spiny cocklebur, Bathurst burr)

Family: Asteraceae

Description*: Xanthium spinosum* is an erect, somewhat woody, and much-branched annual herbaceous, native tropical South America. The plant usually grows to 30-100 cm tall, 1.5 m across, and with spines at the base of the leaves. Stems are striate, yellowish or brownish grey and finely pubescent. True leaves are lanceolate, entire, irregularly toothed or lobed. They are hairy (glabrous or strigose) and a dull grey-green color above, and paler and downy (silvery-tomentulose) beneath, with a conspicuous white midrib. Each leaf base is armed at the axil with three-pronged yellow spines, usually up to 2.5 cm long, often opposite in pairs. Flower heads are in axillary clusters or solitary. Flowers are inconspicuous, greenish, and monoecious, developing into a burr. The burr is two-celled, oblong, nearly egg-shaped, slightly flattened, 10-13 mm long, 4 mm wide, pale yellowish to brown covered with yellowish hairs, more or less striate, glandular, covered with numerous slender, hooked, glabrous spines up to 3 mm long from more or less thickened bases, with the two apical beaks short and straight. Each burr contains two flattened, thick-coated, dark brown or black seeds, about 1 cm long, the lower germinating first. The seeds tend to germinate in late spring beginning of summer. Emergence can occur from spring until late autumn, and new fruits (or burrs) are produced two to three months after germination and emergence *X. spinosum* prefer moist soil, grow along roads, in disturbed areas and abandoned fields, and along streambeds. New fruits (or burrs) are produced two to three months after germination and emergence (Pitcher, 1989). On average, each plant produces about 150 seeds.

Pathway: There is no precise information on when or how *X. spinosum* was introduced, but most probably, the seeds were imported inadvertently together with animal fodders (impure seedstocks), or the fruits of the plant brought in with sheep wool, from South America.

Vectors: *X. spinosum* is spread through several ways, the fruits are dispersed by floating on water, the hooked spines on the fruit adhere easily and cling firmly to wool and fur of animal and livestock, in addition to clothing, bags and any fibrous material, hay bales, and also in mud on shoes, tools or vehicles. Fruits are also spread in contaminated pasture seeds and grains.

Distribution: *X. spinosum* is a species that can be found growing in a wide range of habitats incuding road sides, disturbed fileds, abandoned fields, floodplanies, canals, ditches,

waterholes, and in cultivated fields. *X. spinosum* was recorded along roadsides within Al Jifftlik area in the Jordan valley and Al Nassaryeh within Tubas district, at the western part of Hedera stream, and at the western part of Wadi Masin.

Control and eradication:

Physical control: Control is possible by early mowing, cultivation or crop rotation, or by cutting and burning of the plant before the burrs ripen. (Orchard, 1949; Parsons, 1973).

Chemical Control: *X. spinosum* are best controlled with the broad-leaf selective herbicides. Young plants are easily killed by one application of 2,4-D or MCPA applied to healthy, growing, non-flowering plants. However, older plants need more than one application (Meadley, 1956; Orchard, 1949).

Potential threats: *X. spinosum* is a highly invasive weed that is capable of growing under a range of environmental conditions, and very competitive. It can become established in cultivated fields rangeland, streambanks, displacing agricultural crops (e.g., sunflower, tomatoes, and many other annual and perennial crops) and native species, and alter habitats. (Pitcher, 1989). In addition, burrs can contaminate wool and other material since burrs have hooked spines, potentially affecting export. *X. spinosum* is documented as a poisonous plant, as the seeds contain hydroquinone and the plant in the cotyledon stage are also reported to be toxic. The plant is mainly toxic to animals and livestock.

6.19 *Washingtonia robusta* (Mexican Fan Palm; Washington palm))

Family: Palmae

Brief description: *Washingtonia robusta* is dioecious, single-trunked palm tree, with compact bright green fan-shaped palm fronds, native to the arid and semi-arid areas in the Sonora desert in the southwestern United States and in northwest Mexico. The species has a solitary and tapered stem, upright to 22 m tall and 80 cm diameter, covered with a skirt of marcescent

leaves. Old leaves drop after many years, to leave a smooth gray stem with closely spaced leaf scar rings. Leaves are costapalmate, induplicate, split about half the blade length into numerous segments with stiff tips and threads (marginal fibers) hanging between segments. Many bright green leaves form a full crown 1.5 to 2.5 m wide. Petioles split, armed with curved teeth along orange-colored margins. The adaxial hastula is prominent with tattered, papery margins. The base of the lower surface of the leaf blade densely covered with near white pubescence. The inflorescences are numerous, branched to at least three orders and project from the crown extending beyond the leaves. Fruits are spherical to pear-shaped, up to 1 cm in diameter, and brownish-black to black when ripe. The species is resistant to heat and aridity, it can germinate in shallow, poor soils, even it can grow in the crack between pavement stones. It reproduces only by seeds. In Palestine, *W. robusta* blooms between March and May.

Pathway: *W. robusta* was first introduced to historic Palestine in 1905, as an ornamental tree.

Vectors: Birds are the main dispersal mechanism of the *W. robusta*, which spread the seeds for substantial distances.

Distribution: *W. robusta* is mainly planted on the main entrances to cities, towns, and villages. In addition, it is also planted in house gardens, public gardens, and in some cases along main roads and city centers. The species is recorded in Su'eer city in Hebron district, Al Biereh, Sinjil and Turmus Aya in Ramallah district as will as in Jenin City in Jenin district.

Control and Eradication:
Physical control: Uprooting young specimens is found to be the most effective approach, while mature trees can be cute from their base.
Chemical control: Using drill-fill with glyphosate (50%) showed very successful results, however, imazapyr herbicide is preferred in wetland and riparian zones.

Potential threat: outcompete other plants due to their dense root masses, and by creating shade. Moreover, the accumulation of dry leaves along the trunk increases the danger of fires. The species is also found to be a prefereable nesting site for several invasive alien bird species such as the Monk Parakeet, and the rose- ringed parakeet.

6.20 *Acacia victoriae* (Elegant Wattle, Bramble Wattle)

Family: Fabaceae

Description: *Acacia victoriae* is a shrub/ tree native to Australia. The tree is dense, thorny, and can reach up to 5 m heigh. Phyllodes are green to grey in color and have various sizes and shapes (linear, elliptical, straight, or curved), around 2-5 cm long and 3-8 mm broad. Phyllodes also have one central vein numerous lateral viens, as well as small glands near base. *A. victoriae* inflorescences is a raceme up 10 cm long, with 15-30 yellow-colored globular heads. Each head has 15-30 extremely small flowers. *A. victoriae's* pods are 8 cm long and 9-16 mm wide, and dark brown seeds lie horizontally within. *A. victoriae* blooms in our region from mid-March to May. *A. victoriae* has high drought tolerance due to its complex root system that can penetrate to about 20 m in the soil. Beds and banks of the wadis in arid and semiarid areas are *A. victoriae's* favorite habitats. The tree grows fast and has a lifespan of 10-15 years. *A. victoriae's* pods produce massive number of seeds; the tree can reproduce by root suckers as well.

Pathway: *A. victoriae* was introduced to historical Palestine more than 50 years ago for afforestation by Israel Jewish National Fund, but did not proliferate until late 2005 in the northern Negev, which means that residence time was 35-45 years.

Control and eradication Mechanical control is ineffective due to the tree's ability to regenerate from root suckers. No herbicide, nor a biological control is available against *A. victoriae*, yet.

Potential threats: similar to other Acacia species, *A. victoriae* forms thick dense ?? that displaces native species. *A. victoriae* also competes with native species over water and forms forest-like structures in desert ecosystems, therefore encourage nesting on local bird species such as the hooded crow, which may threaten other local bird species.

6.21 *Cyperus involucratus* (Umbrella sedge)

Family: Cyperaceae

Description: *Cyperus involucratus* is a perennial herb native to east Africa. It is a rhizomatous plant, evergreen, densely clumping, tender perennial sedge, typically grows to 50-180 cm tall. *C. involucratus* is a completely smooth species, with many thick erect ridged stems. The stems are triangular to almost cylindrical in cross-section, hairless and sometimes slightly ridged lengthwise. The true leaves are reduced to long sheaths, 10-20 cm long, light brown, and cover the bases of the stem. The stems bear umbelliform inflorescences, composed of 14-24 straight and narrow leafy bracts, 10-30 cm long and 4-17 mm wide. The bracts around the inflorescence are rough, with protruding veins, spread horizontally and drooping slightly at the edges, giving the plant an umbrella-like appearance. The spike bears 6-18 compressed spikelets, ovoid or oblong, 3-12 mm long and 1.5-3 mm wide. Each spike bears 8-36 tiny yellow-greenish or light brown flowers 2 mm long and 1.1 mm wide. *C. involucratus* grows in moist habitats such as riverbanks, streams and marshes. The species reproduces mainly asexually through pieces of rhizomes that break off the parent plant. *C. involucratus* is a very competitive plant species, can become established in the middle of native vegetation. It is resistant to high temperature and salinity, and does not require a specific soil type. In Palestine, *C. involucratus* blooms in the summer.

Pathway: *C. involucratus* was deliberately introduced into historical Palestine as an ornamental species and planted in many gardens. The exact year of introduction is unknown, but the first records of the species in the wild are from 2004, in the Jerusalem Mountains.

Vectors: *C. involucratus* is dispersed naturally through the spread of the fallen rhizome's pieces from the parent plant. Flowing water (stream, roadside, floods etc.,) carry the fallen rhizomes, stem segments, and roots to establish new populations. No evidence that animals or livestock plays any role in the dispersal of this plant species. The species is grown widely in nearby countries that share some of the main wadis and stream, and planted within the illegal Israeli settlements, which might facilitate the dispersal of this invaded species.

Distribution: *C. involucratus* is documented in a few places within the west central part of Wadi Qilt.

Potential threats: *C. involucratus* forms extremely dense stands, very competitive, resistant to high temperature and salinity, therefore it displacse native species, and dramatically modifies the character of streams and wadis vegetation in invaded areas.

6.22 *Acacia salicina* (Willow wattle, Willow Acacia)

Description: *Acacia salicina* is an evergreen tree, from the family Fabaceae, native to Australia and New Zeeland. The shrub/ tree ranges from 3-13 meters in heights in its native range, while it can reach up to 5 m tall in Palestine with dropping branches. Its branchlets are pendulous, smooth and greyish-brown in color. The phyllodes of *A. salicina* are pendulous, linear to oblanceolate or elliptic in shape, 7-20 cm long, 4-30 mm wide. Usually there are 2-5 gland at the base of phyllodes. *A. salicina* flowers are 5-6.5 cm long having pale-yellow globular heads. Finally, *A. salicina's* raceme bears 15-25 small flowers. The pods can be up to 12 cm long and 7-13 mm wide in a long and narrow shape. *A. salicina's* seeds are black, 4.5-6 mm long. *A. salicina* blooms in our region from late summer to the end of autumn season. *A salicina* needs more than 125 mm of average annual rain to grow. Moreover, the tree is resistant to drought and can tolerate cold weather up to -5°C as well as high soil salinity. *A. salicina* habitat includes sandy soils, stream banks, and flat areas in the semi- arid regions. The plant is a fast-growing tree, and reproduces by seeds and root suckers. *A. salicina* can live up to 50 years, and only known as invasive species in historic Palestine, and the West Bank area.

Pathway: ***A****. salicina was* introduced to historical Palestine during the British Mandate, thereafter the Israeli Jewish National Fund also planted the tree in the semi-arid regions to stabilize stream banks and sands. *A. salicina was* also planted in the northern Negev to be evaluated as fodder. The results showed that similar to *A. salinga,* the *A. salicina* cannot be used as a food source only to small ruminants due to its high tannin content.

Vectors: The Ministry of Agriculture planted the species as part of an afforestation and rangeland rehabilitation efforts. In addition, the species reproduces by seeds, as well as root suckers, therefore it can spread naturally, as well as by water (in streams or floating water).

Distribution: The ministry of agriculture is the main Palestinian body that plants this species as part of their ongoing rehabilitation efforts of rangeland, mainly within governmental land, near nature reserves, and coneferious forests. The species was recorded in Dair Ghazaleh, Jabal Tamoun Nature reserve and in the eastern parts of Siris nature reserve.

Control and eradication mechanical control is not successful as *A. salicina* has the ability to regenerate after cutting. No sufficient data is available for chemical nor a biological control since the species is only considered as invasive in historic Palestine.

Potential threats: *A. salicina* in its invasive range is found to have the ability to change the characteristics of local vegetation and natural ecosystems, as it forms dense tree stands and thickits particularly in wadis and open areas with low shrubs and herbaceous plants. Moreover, *A. salicina* competes with native species over water and soil, and almost no vegetation can grow under its canopy

Palestinian National Strategy for Mitigating and Managing the Threats of Invasive Alien Species

1. The need for a strategy

Palestine possesses a very rich biodiversity due to its distinct location in the center of three continents, and having five different phytogeographical regions; Mediterranean, Irano-Turanian, Saharo Arabin, and Sudanese penetration. Additionally, it is estimated that 51,000 living species live within historic Palestine, constituting about 3% of the world's biodiversity (Sixth national report. It's worthwhile mentioning that out of the 2067 plant species that are reported in Palestine, 636 species are considered rare, and 90 species are very rare. There are 51 nature reserves, 14 key biodiversity areas in the West Bank, and one in Gazza Strip. Therefore, protecting this natural wealth from IAS and their adverse negative impacts requires a comprehensive national strategy.

Invasive alien species by definition are organisms living outside their native range of distribution, introduced accidently, naturally, or intentionally and become established in the new invading area, reproduce and spread. IAS compete with native species and cause harm to the invaded ecosystems. The negative impacts caused by IAS can be extensive affecting biodiversity, agriculture, health, food security, and socio-economy.

The sixth Palestinian National report submitted to the Convention on Biodiversity (2022), identifies IAS as one of the challenges facing the Palestinian environment causing habitat loss and fragmentation. Moreover, the report calls for an urgent comprehensive survey and assessment of IAS in order to develop the national IAS strategy.

The conducted IAS survey showed that there are 23 IPAS, 4 IBAS, 14 IAIS including 5 freshwater and land snail species, 1 mammal, and one reptile currently present in Palestine. This number is probably higher due to the lack of access to many IAS-high potential areas due to the Israeli occupation. Furthermore, IAS and their adverse negative effects are poorly studied by Palestinian research bodies. Also, many invasive species threats exist from neighboring countries that can enter to Palestine in a natural way, or by trade, and tourism.

State of Palestine ratified the CBD in 2015, accordingly Palestine needs to conserve its biodiversity, and ensure a sustainable use for its natural resources to meet the needs of the current and future inhabitants of Palestine. Preparation of the Palestinian National Invasive Species Strategy and Action Plan as a cross-cutting issue, is in accordance with the Palestinian obligations towards CBD at the national level.

2. Preparing the strategy and action plan:

The Palestinian National Strategy for Mitigating and Managing the Threats of Invasive Alien Species is based on:

a. Results of a survey for the different IAS taxa in Palestine.

b. Information collected from a desktop study for existing data and research concerning IAS in Palestine.
c. Consultations with key stakeholders via three workshops.
d. The findings from a questionnaire that was distributed to stakeholders.
e. Guidance and obligations in international agreements.

3. Audience of the Palestinian National Strategy for Mitigating and Managing the Threats of Invasive Alien Species:

The Palestinian National Strategy for Mitigating and Managing the Threats of Invasive Alien Species objectives and activities will help the government, researchers, relevant businesses, and civil society organizations to work in a harmonized matter to protect the natural wealth and livelihoods of Palestinians from IAS and its adverse negative effects.

4. Vision:

To protect Palestinian natural heritage and rich biodiversity sites and reach a healthy environmental balance by establishing a biosecurity system that manages IAS in Palestine and reduces their negative impact.

5. Mission:

The "Palestinian National Strategy for Mitigating and Managing the Threats of Invasive Alien Species" aims to take the effective and urgent actions needed to reduce the biodiversity loss and preserve Palestine's environment by protecting native species and subspecies from IAS, strengthening the management response to IAS and minimize their negative impact by enhancing knowledge, research and increase public awareness and understanding to mobilize cooperative action against IAS.

The strategy is meant to serve for the period 2022- 2030, and covers various taxonomic groups with special focus on high priority species and sites.

6. Strategic objectives:

The objectives followed by the Palestinian National Strategy for Mitigating and Managing the threats of Invasive Alien Species adopts three main thematic areas (Figure 1):

1. Theme A "Basics": This theme focuses on establishing the right foundations to manage efficiently IAS in Palestine and includes generating support from various involved stakeholders, capacity building targeting individuals, organizations, and communities, and to develop and enforce appropriate legislations and policies. Moreover, this theme includes actions and activities that aims to increase public awareness, and promote education concerning IAS.
2. Theme B "Baseline and Monitoring": this theme focuses on the best tools towards decision making, and risk assessment of IAS as a constant threat to biodiversity and livelihood in Palestine.

3. Theme C “Management”: this theme focuses on IAS spread prevention mechanisms, and management of already established species by eradication or control. Additionally, actions and activities with respect to site restoration after IAS have been removed.

Figure 1: Chain of thematic areas, objective, and actions adopted by the action plan

➢ **Thematic area A:**

Objective 1: To survey and identify the most common IAS and their adverse negative effects on biodiversity, human health, and environment, and to create various supporting systems to manage and decrease their impacts.

✓ **Objective 1 actions include:**

1.1 Increase the public awareness and outreach on IAS through establishing information center, media, science citizen.
1.2 Promote education concerning IAS and its adverse negative effects.
1.3 Promote public awareness concerning releasing/ escaping exotic pets into the wild.
1.4 Prioritize IAS management in the Palestinian national strategies.
1.5 Funding is available to implement proposed activities in the IAS national plan.
1.6 Mainstreaming of IAS into the NBSAP and other national strategies and action plans
1.7 Strengthening the cooperation between all stakeholders to eradicate, control and manage the IAS.
1.8 Promote research on IAS focusing on best methods of eradication and management.

Objective 2: To build the national capacity of individuals, organizations, and communities towards identification, control, and management of IAS.

✓ **Objective 2 actions include:**

1.1 Capacity building concerning IAS identification, control, and management at the individual level.
1.2 Develop capacity to use risk assessment and incorporate such methodologies in environmental impact assessments.
1.3 Develop financial measures, and other policies and tools, to promote activities to reduce the threat of invasive alien species.
1.4 Capacity building targeting organizations at the national level.
1.5 Capacity building targeting local communities mainly rural.

1.6 Capacity building for risk control and management of IAS
1.7 Infrastructure improvement for research and control

Objective 3: To develop and establish a proper and active legislations and policies in order to support the effective management and control of IAS.

- ✓ **Objective 3 actions include:**

3.1 Regulations and policies related to IAS are passed complementing the Environment law in order to prevent IAS entry, and to improve IAS's control and management.

- ➢ **Thematic area B:**

Objective 4: To adopt and establish methodologies and set-ups for baseline surveys evaluating the status, distribution, and impacts of IAS.

- ✓ **Objective 4 actions include:**

4.1 The status of IAS and their adverse impacts on biodiversity, ecosystems, human health and environment are determined through systematic surveys.
4.2 Proper documentation to the status of IAS and their adverse impacts is established.

Objective 5: To develop and establish risk assessment protocols for enabling prioritization of IAS.

- ✓ **Objective 5 actions include:**

5.1 Risk assessment protocols and procedures with respect to environment, biodiversity, health, socio-economic status are developed.
5.2 Capacity building concerning IAS risk assessment protocols and procedures.
5.3 Prioritization IAS in accordance with the risk assessment procedures.
5.4 Conduct research on prioritized IAS.

- ➢ **Thematic area C:**

Objective 6: To develop and establish an effective early detection mechanism to prevent new incursions, and methods to prevent spread of established IAS.

- ✓ **Objective 6 actions include:**
  6.1 Quarantine and border inspection procedures, protocols and mechanisms are established/improved to prevent new IAS entries to Palestine.
  6.2 IAS treatment procedures are established.
  6.3 Mechanisms for controlling the spread of established IAS in Palestine are active.
  6.4 An Early Detection and Rapid Response system is established and activated.

Objective 7: To eradicate and control established IAS species when applicable.

- ✓ **Objective 7 actions include:**

7.1 Best practices for management of established IAS are implemented.

7.2 High risk IAS are eradicated when possible.
7.3 Identify and develop biocontrol agents to control high risk IAS when possible.
7.4 High risk IAS are controlled when eradication is not possible.

Objective 8: To recover and restore the native biodiversity after implementation of eradication and control procedures.

- ✓ **Objective 8 actions include:**

8.1 Restoration of the targeted sites mainly the most infected by IAS, after management plans are executed.

7. Governance of the Strategy and Action Plan:

The Environmental Quality Authority is responsible on administering and coordinating actions and activities in the strategy and action plan. Other governmental ministries are directly involved (competent authorities) including the Ministry of Agriculture, Ministry of Health, Ministry of National Economy, Ministry of Tourism and Antiquities, Ministry of Education, Ministry of Higher Education and Scientific Research, Ministry of Local Governance, and the Ministry of Justice.

8. Policy implementation:

Implementation of this strategy is the responsibility of the EQA in coordination with related IAS competent authorities. EQA is also in charge of reviewing and adapting the strategy, as well as setting up an adequate monitoring and evaluation plan to ensure proper implementation of the strategy and action plan. As suggested previously a "National IAS department" is recommended to be formed within the EQA and should be supported technically, financially, and proper expertise to deal with IAS related issues. The IAS department must adopt a multi-sectoral approach with all relevant ministries (especially MoA) to ensure proper management of IAS, and deal effectively with their adverse negative effects.

The IAS department staff responsibilities include:

1. Ensure the implementation of the actions and activities related to the IAS national strategy and action plan.
2. Coordinating among all competent authorities.
3. Follow up and guide IAS related research.
4. Update IAS inventories, experts, related projects, relevant procedures, etc.
5. Organize IAS related public awareness campaigns.
6. Organize capacity building activities targeting different sectors.
7. Exchange data with regional and international IAS initiatives and networks.
8. Annual systematic surveys to determine IAS's status, and their adverse negative effects.
9. Create mechanisms for eradicating, controlling, and managing established IAS.
10. Site restoration after eradication of IAS.

Moreover, the “national surveillance department” within the EQA, will be responsible on the “early detection and rapid response” system. Including preparation of the national alarm list, watch list, and black list, as well as the preparation of accompanying EDRR reporting requirements. It is urgent to adopt the IAS bylaw proposed by this document to complement the Environmental law for the year 1999, in order to ensure suitable implementation and enforcement of IAS prevention and management actions.

Competent authorities are responsible on prohibiting IAS from being imported to the State of Palestine or traded between the State of Palestine and another country. Additionally, competent authorities are to give permits to raise or transfer IAS in certain cases and under controlled conditions.

Operational implementation and enforcement of the strategy and action plan will be achieved by the EQA IAS department staff, environmental police, and border Customs inspectors.

9. Financing:

The “IAS national department”, and the “national surveillance department” staff and infrastructure expenditure is the responsibility of the Palestinian government. Attracting fund for research can be done through relevant grants and international funding submitted by EQA, competent authorities, NGOs, research institutes, and universities. The government shall attract donations to support the implementation of this strategy’s actions and activities.

Legal Framework for Invasive Species in Palestine

1. Background:

Invasive alien species are considered the second global threat on biodiversity and impose a common challenge worldwide, threatening ecosystems, habitats, indigenous species, and biodiversity. Although extensive research exists regarding the effect of IAS on native species, changes in habitat, and the introduction of pests and diseases, however, no adequate regimes, legislations, or guidelines have been developed both at the national and international levels, but currently the situation is improving.

In Palestine, as in many other countries, efforts to address IAS at the legislative levels are fragmented, whereas most efforts are placed in the agricultural related sector. Most legislations, frameworks, and guidelines are adopted from international non-binding conventions, rather than being developed nationally. Above all, legal actions are taken after the IAS and their pathways are apparent, coupled with a serious lack of clear procedures regarding eradication and control.

The importance of having a nationally-designed legal framework can assist in preventing or minimizing the risks imposed by IAS, as well as, provide efficient eradication and control measures. Furthermore, legislations must be accompanied by institutional mechanisms to implement regulations, monitor, and regularly revise for necessary legislative changes. National legal frameworks can assist in the design of international frameworks, and act as incentive for further development and engagement within the international efforts.

Legal experts often describe IAS as “self-regenerating pollution”, yet biological invasions are usually more complex than common types of pollution. This can be attributed to the fact that IAS have multiple pathways for introductions, coupled with data gaps on native species. Moreover, it is difficult to forecast which alien species will be able to reach the invasiveness phase, as there are no clear criteria nor methodologies for assessing IAS risks. Additionally, in many cases trade activities and production are associated with IAS, which compromises a value to locals and stakeholders. Very often invasion occurs in private lands causing an extra challenge on legislations. Finally, and most importantly, a low level in political and public awareness concerning the threats imposed by IAS hinders the development of legal frameworks in this regard.

Although IAS threatens native biodiversity, however their introduction are international in character, therefore, the problem is increasingly looked at from a global approach. IAS recognized no political borders, consequently bilateral, regional, and global actions and instruments had been developed to tackle them. Palestine has ratified to 15 different international binding agreements voluntarily which includes regulations on IAS. Below is a list of the most important relevant international agreements.

2. International Agreements

2.1 The Convention on Biological Diversity (CBD):

Palestine ratified the CBD on the 2nd of April 2015, which calls on governments to establish systems of protected areas and to manage them, in order to support conservation, sustainable use, and equitable benefit sharing. The governments recognized nature reserves as economic institutions that have a key role to play in the alleviation of poverty and the maintenance of the global community’s critical life-support systems.

Article 8(h) of the CBD (1992) declares, “Each contracting party shall, as far as possible and as appropriate, prevent the introduction of, control or eradicate those alien species which threaten ecosystems, habitats or species”. The article requests from parties to prevent, eradicate and control IAS threatening biodiversity, but did not take into consideration international trade as a crucial pathway of introduction. The article also did not address the constrains imposed by lack of resources, knowledge, and political will. The article lacked guidance on how to achieve its aims.

In 1998, the Conference of the Parties (COP) acknowledged IAS in separate thematic decisions due to the urgency to address their threats at its fourth meeting (decision IV/1). The decision recognized the threats imposed by IAS as a “cross-cutting issue” negatively effecting indigenous communities, and national economies. Later the Subsidiary Body on Scientific, Technical and Technological Advice developed the “Interim Guiding Principles for the Prevention, Introduction, and Mitigation of Impacts of Alien Species” at the COP’s request.

2.2 Agreement on the Application of Sanitary and Phytosanitary Measures:

It is one of the agreements by the World Trade Organization that address food safety, animal health and plant protection. This agreement is not specific to IAS, but as the focus is on pests, diseases, sanitary and phytosanitary issues of which many of them are invasive alien species and are affecting international trade. The agreement was enforced in 1995, meanwhile Palestine is not a World Trade organization member yet.

The agreement encourages members to adopt national measures and standards that:

1. Protect human, animal and plant life or health from the risks arising from the entry, establishment or spread of pests, diseases, or disease-carrying organisms or disease-causing organisms.
2. Prevent or limit other damage within the territory of the Member from the entry, establishment or spread of pests.

The national inquiry point that is responsible on ratifying to the agreement is the Palestinian Ministry of Agriculture.

2.3 Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES):

CITES is an international treaty to prevent species from becoming endangered or extinct due to international trade. Parties in the convention work together to ensure the survival of wild populations subjected to international trade. The convention does not forbid ratified parties from adopting domestic measures to restrict or prohibit trade in species as well. The agreement has been used in Europe to address specific IAS. CITES was signed in Washington in 1973 and entered in force in 1975, the treaty is considered as the most important agreement protecting wild species. Palestine is not a Party member of CITES.

2.4 Convention on Migratory Species of Wild Animals (CMS or Bonn Convention):

The convention took place in Bonn (Germany) in 1979, while its enforcement began in 1983, and works under the aegis of the United Nations Environmental Program. The treaty is the only global one concerning migratory species. The international treaty aims to protect the migratory species of wild animals and their habitats and requires Parties to take prevention and management measures. Article II, 4c and article V,5 considers IAS as a threat to migratory species. Palestine is not a Party member to CMS.

2.5 Convention on Wetlands (Ramsar Convention):

The convention was signed in the city of Ramsar, Iran, in 1971. It is considered as the oldest convention for the wise use of wetlands and water resources worldwide. The convention initially focused on waterfowl habitat and had no provision on invasive species. Nevertheless, in 1999, the conference of Parties adopted a comprehensive resolution on IAS and wetlands (Resolution VII/14). The convention also emphasizes that prevention and early intervention against IAS are the most cost-effective techniques. The convention urges all Parties to address the environmental, economic, and social impacts of IAS on wetlands by conducting the following:

a. Preparing inventories for IAS in wetlands within each Parties territory.
b. Establishing eradication programs when necessary.
c. Reviewing and adopting new legislation to prevent introduction of IAS.
d. Developing capacity for IAS identification
e. Facilitating awareness, resources, identification and control of new IAS.

Palestine did not ratify to Ramsar Convention yet.

2.6 International Health Regulations (IHR):

The treaty aims to prevent the international spread of diseases, therefore ratified Parties are requested to prevent international spread of diseases, reduce sources of infection, and diseases. IAS serves as hosts or vectors for diseases affecting human and animal health, therefore Parties of IHR must adopt measures to control the introduction and spread of IAS. The agreement was adopted in 1969 (Geneva), and revised in 2005.

2.7 International Plant Protection Convention (IPPC):

The treaty was signed in 1951 (Rome), revised 1997, and aims in Article 1.1 to "secure common and effective action to prevent the spread and introduction of pests of plants and plant products, and to promote appropriate measures for their control". In 2003, the IPPC workshop was held on IAS. Currently there are 184 contracting parties in the convention, unfortunately Palestine is not one of them yet. As IAS can be considered as pests, therefore, falls within the scope of IPPC and its regulations. IPCC urges Parties to adopt legislative, technical, and administrative procedures and standards to identify pests, and prevent their introduction and spread.

2.8 United Nations Convention on the Law of the Sea (UNCLOS):

The treaty that was signed in 1982 (Montego Bay) aiming to specifically protect the marine environment from intentional or unintentional introduction of IAS. Article 196 requires Parties to "take all measures

necessary to prevent, reduce and control the intentional or accidental introduction of species, alien or new, to a particular part of the marine environment, which may cause significant and harmful changes thereto". Palestine is not a Party in the treaty.

2.9 United Nations Convention on the Law of Non-Navigational Uses of International Watercourses:

The treaty that was adopted in 1997 aiming to prevent the introduction of species, alien or new, into an international watercourse. The treaty is ratified only by 36 states, while the most important relevant countries are not included yet. The convention is an important step in establishing international law governing water.

2.10 World Organization for Animal Health Agreement:

The agreement was signed in 1942, and has 183 countries and territories members. It aims to improve animal's health worldwide. The agreement includes international standards, guidelines, and recommendations for animal health to guarantee safety of international trade and control diseases worldwide. IAS are considered as pests/ disease therefore they are included in the agreement as well.

3. Guidelines and Codes of Conduct:

3.1 Agenda 21:

Agenda 21 was adopted by the United Nations Conference on Environment and Development, which was held in Rio de Janeiro in 1992 in response to the threats imposed by IAS. The agenda contains the following proposals addressing IAS:

a. Chapter 11 that calls for combating deforestation by preventing introduction of pests, diseases, and exotic plant and animal species. The proposal also urges Parties to regulate inter-border movement of plants and related materials.
b. Chapter 15 acknowledges IAS as a major cause for biodiversity loss.
c. Chapter 17 encourages development of legal and regulatory frameworks for maricultural/ aquacultural issues to prevent introduction of IAS.
d. Chapter 18 encourages control of noxious aquatic species.

The non-binding treaty addresses the impact of IAS in a wide range of sectors such as combating deforestation, conserving biodiversity, and protecting waterbodies.

3.2 Food and Agriculture Organization (FAO) Code of conduct for the Import and Release of Exotic Biological Control Agents:

The code of conduct was signed in 1995, aiming to facilitate safe import, export, are release of biological control agents internationally by providing safe and acceptable guidelines, procedures, standards, and a source of legislations. The code is generally directed to best management practices of fisheries, moreover specific provisions are focused on nonnative species and genetically modified ones. IAS related code calls member states to adopt measures to minimize their harmful effects, especially where there is a large potential for IAS to spread. In the same year, the FAO also released the "Code of Conduct for Responsible Fisheries", and the "FAO Technical Guidelines for Responsible Fisheries:

Precautionary Approach to Capture Fisheries and Species Introductions", both containing codes of conducts against the introduction and spread of IAS as well.

3.3 International Plant Protection Convention: Guidelines for the export, shipment, import and release of biological control agents and other beneficial organisms:

The International Standard of Phytosanitary Measures #3 (ISPM 3) was adopted in the 7th session of the Interim commission on Phytosanitary in 2005. ISPM 3 provides guidelines for risk management concerning export, shipment, import and release of biological control agents and other organisms. ISPM3 also reflects on biological control agents capable of self-replication (parasitoids, predators, parasites, nematodes, phytophagous organisms, and pathogens such as fungi, bacteria and viruses), sterile insects, and packaged as commercial products.

3.4 IUCN Guidelines for the Prevention of Biodiversity Loss Caused by Alien Invasive Species:

The aim of the guidelines (adopted in 2000) is to prevent further losses of biological diversity due to the deleterious effects of IAS. It is designed to help governments and management agencies to implement Article 8 (h) of CBD previously discussed.

The guidelines focus on four major concerns of IAS; improving understanding and awareness, strengthening the management response, providing appropriate legal and institutional mechanisms, and finally enhancing knowledge and research efforts.

The legal recommendations of the guidelines call-on giving a high priority to developing national strategies and plans against threats imposed by IAS, moreover implementing the provisions of international treaties dealing with IAS.

3.5 IUCN/ Species Survival Commission (SSC) Guidelines for Re-Introductions:

These guidelines were prepared by IUCN Re-introduction Specialist Group of the SSC in 1995, due to the increasing number of re-introduction projects all over the world, and the need of specific policies and guidelines in this regard, in order to avoid possible side effects of the re-introduction process (unintentional introduction of IAS) rather than conservation benefits.

3.6 IUCN Technical Guidelines on the Management of Ex Situ Populations for Conservation:

The guidelines were approved by the Program Committee of Council in 2002. It aims to maintain present biodiversity level, as well as, responsibly managing ex-situ propagation, translocation, and other ex-situ methodologies where appropriate to maximize conservation efforts. Management of all ex-situ should take into consideration the risk of invasive escape from propagation display and research facilities. Moreover, each taxa should be assessed for their invasive potential, and proper controls to avoid escape and naturalization of IAS.

4. Legislations and recommendations:

4.1 National Legislations

Article 33 of the amended basic law of the State of Palestine that was issued in 2003 states that: "The enjoyment of a balanced and clean environment is a human right. The preservation and protection of the Palestinian environment from pollution for the sake of present and future generations is a national duty". Article 33 directly links environmental preservation and protection to sustainability and to the importance of citizen's involvement in the process. Both the EQA and the MOA are the governmental bodies authorized to develop legislations, strategies, policies, and guidelines related to IAS in Palestine.

The Environmental Law for the year 1999 defines "environmental pollution" as "any direct or indirect change in the environment characteristics which may lead to damaging one of its elements or breach its natural equilibrium". While Article 2 states that the law aims to "protect the environment from all forms and shapes of pollution", and as previously stated experts consider IAS as a form of "self-regenerating pollution", therefore the law indirectly calls to protect the Palestinian environment from the effects of IAS.

Article 5 (b) guarantees to "Protect the country's natural wealth and its economic resources as well as maintain its historical and civilization heritage without damage or side effects which may appear sooner or later as a result of the different industrial, agricultural or constructional activities on the basic life species and the environmental systems such as air, water, soil and sea, animal and botanical wealth", which can also be reflected on preventing and combating IAS in Palestine in order to maintain its natural wealth, and prevent damage imposed by IAS on biodiversity and its components.

Article 40 of the Palestinian Environmental Law positions the EQA in cooperation with competent authorities responsible for preserving and supervising natural reserves and national parks, which implicitly includes the introduction, spread, and transformation of IAS. Whereas Article 42 of the same law puts EQA and competent authorities in charge of preserving biological diversity in Palestine, of which IAS is a major threat.

Article 43 states that "The Ministry shall undertake, in coordination with the competent authorities, to formulate the basis and criteria which would determine the forest plants and trees whose picking, cultivation, destruction or cutting is temporarily or permanently prohibited in a manner that ensures its existence or continuity". Therefore, Article 43 designates the criteria of forests cultivation to the relevant governing bodies (EQA, and MoA), which gives the competent authorities the legal tool to forbid the introduction of exotic species.

Article 44 of the environmental law prohibits any person to damage natural reserves, forest areas, and public parks. As IAS has a negative effect on the environment and its components, thereafter Article 44 could be used to prevent any introduction of IAS.

Article 75 states that: "In implementation of the provisions of this law or any international conventions concerning the environment in which Palestine is a party therein, the Ministry shall, in coordination with the competent local authorities in cooperation with the counterparts thereof in the countries contracting therewith, exchange the scientific and technical information as well as coordinate its programs in the field of environmental research with common capacity, formulate joint cooperation programs in the field of preventing or reducing the environmental pollution and exchange the various assistances relating therewith". As a result, Article 75 encourages the implementation, exchange of

scientific and technical information, and formulate joint cooperation programs related to IAS (pollution) with the counterpart ministry in the countries contracting on the same international conventions such as the CBD.

Finally, Article 77 pronounces that: "According to the provisions of the law, the international or regional conventions and agreements as well as the provisions of the international organizations in which Palestine is a party or any other laws relating to the environment, which are valid in the Palestinian territories shall be considered as a complementary part to this law unless it has been expressly provided otherwise". Consequently, according to Article 77, all conventions or treaties related to IAS that Palestine has ratified to, is considered as complementary to the environmental law, which could fill a gap in the governing national legislations.

Article 39 of the Agriculture law for the year 2003 affirms that MoA shall develop regulations in plant nurseries that sets the conditions of importing, exporting, and marketing, as well as, controlling agricultural pests. This article is highly relevant to IAS introduction as in many cases the pathway of introduction of certain invasive plant species was through imported plants/ soil such as the highly invasive *Ambrosia confertiflora.*

Articles 45, 46, and 47 of the agriculture law are dedicated to agricultural pests, which can also be related to IAS. MoA is responsible for announcing the types of agricultural pests, and methods of prevention according to the law. Moreover, the Minister is in charge of safeguard and prevention of the spread of the disease or pest. The Minister of Agriculture must announce infected areas, designate its borders, and regulate transition of infected plants and soil. Furthermore, the Minister must issue the guidelines for combating infected plants, means to stop the spread, and instructions to control the pests.

MoA is also responsible of agricultural quarantine according to Articles 52 and 53, whereas importing of plants, agricultural products, soil, genes, genetic origins and biotechnologies needs to be subjected to agricultural quarantine. This is an essential law to prevent entrance of IAS to Palestine, where quarantine acts as the first defense line against their contamination and spread. By law, the Minister must define work procedures at agricultural quarantines, methods of examination, and develop and observe the conditions of import, transit, or export of plants and agricultural products. Although there IAS are not directly mentioned in previously discussed articles, nevertheless, by definition IASs are subjected to them.

Finally, Article 73 is dedicated to fisheries, where the Council of Ministers is responsible of regulating the import, export, and marketing of fish and other aquatic beings and trading them, which includes regulating IAS.

4.2 Recommendations:

As seen before, both in the Environmental law for the year 1999, and the Agricultural law for the year 2003, there were indirect implications to IAS, while clear definitions and comprehensive guidelines were missing. Even though, ratified international conventions and treaties may fill legislative gaps, still this does not eliminate the need for a customized national law addressing IAS in Palestine. The national law addressing IAS should be balanced to address the interests of horticulture, pet trade, private actors as well as preserve nature and biodiversity. Additionally, the law should include obligations to raise political and public awareness and encourage scientific research regarding IAS in Palestine. The law should clearly identify the sectors and pathways associated with IAS introduction, and identify governmental departments that have the mandate to manage and control IAS. Most importantly, the

law must include nationally tailored cost-effective mitigation measures to combat IAS, and support policies that prevents introduction of potential IAS.

The objectives of the national law should focus on:

- Protecting native species and subspecies from IAS threats.
- Protecting flora, fauna, and human health from pests and pathogens caused by IAS.
- Protecting biodiversity, ecosystems, natural resources, and ecological processes from IAS threats.

As IAS can invade all ecosystems, the national law must include legal frameworks to cover all parts of the country. Many environmental legislations worldwide focus on terrestrial invasions especially where agriculture and forests are concerned, and neglect aquatic ecosystems, fisheries, and vulnerable protected areas.

Usually, general terminologies are defined within legislations, and the national law addressing IAS should be no exception. Clear definitions on the most prominent terms such as; native, alien, genetically modified, invasive, pest, introduction, etc. must be included. Where applicable internationally agreed upon terminologies should be adopted.

The first part of this report shows that scientific research related to IAS in Palestine is very poor, and impacts of IAS are not estimated. This may form a challenge to build political will for new relevant legislations. Minimally, legislations should support constant identification and monitoring of IAS national level. Moreover, efforts to fill knowledge gaps about native species, local biodiversity, and potential threats imposed by IAS should be encouraged. For example, New Zealand has a specific legal basis for gathering and monitoring data concerning IAS under the Biosecurity Act of 1993. Collected information is used for developing pest management strategies.

The national law should also take into consideration the implementation and enforcement of international standards, quarantine measures, and transport controls. The introduction of new species should be appropriately addressed by the law, either by applying preventative and precautionary measures, or by using permits to control their entrance to the country. The release of exotic species should be prohibited near vulnerable ecosystems, nature reserves, and key biodiversity areas. Moreover, the national law related to IAS should provide an early warning system mechanism for fast responses in the case of biological invasion. Eradication and control measures and techniques should be included in the law, especially for problematic species on the national level. Those measures should be reviewed and updated periodically.

Imported exotic pets is a serious pathway for introducing IAS, which in many cases have severe ecological impacts. Legislations should forbid unauthorized introduction of exotic pets, moreover, a list of exotic pets that could survive in the wild should be prepared based on regional information and assessments. Legally imported exotic pets should go through quarantine before entering the country. The law should prohibit freeing of exotic pets (including potential invasive species, and IAS) coupled with penalties in case of violations.

The national law of IAS should support research, training, education, and public awareness. Recommendations of these categories will be discussed more in depth later in this report, as regulatory frameworks are not sufficient on its own to address challenges imposed by IAS. Finally, the law must include which governmental institutions are responsible on applying the law and coordination

mechanism upon different parties. Technically the law should include sufficient data and advice to border control and quarantine officers as well.

Legislations should also include measures to encourage biodiversity restoration and conservation, reintroduction of native species, and recommendations to restore native habitats and ecosystems that have been invaded by IAS. On the other hand, clear penalties must be provided to control IAS. Penalties must include "stop orders" wherever damages from IAS are found, along with withdrawal of permits when violations of importing agricultural products or pets take place. Additionally, the illegal release of domestic exotic pets, breaching quarantine, and avoiding mandatory control and eradication measures must be penalized by law.

Even though the Eastern Mediterranean countries share, to some extent similar biodiversity, ecosystems and IAS, consequently similar threats caused by IAS coupled with an ease in contamination spread, nevertheless, there are no regional frameworks to combat IAS so far. Such legal regional treaties can also assist in border controls and mitigation strategies.

4.3 Proposed by-law on Invasive Alien Species

Proposed By-Law on Invasive Alien Species under the Environmental Law No.-7 for the Year 1999-Palestine

[Contents]

a) Chapter 1

Objective, Scope and Definitions

Article 1

1) This Law aims to protect native biodiversity, animals, plants, plant products, biological resources, ecological processes, and human health against the impacts of invasive alien species (IAS).
2) The Law also aims to protect species, subspecies, and races from hybridization or extinction by being contaminated by IAS.
3) This Law covers IAS from all taxonomic groups living in terrestrial, marine, inland water, agricultural, fisheries, and forestry ecosystems.
4) The purpose of this Law is to prevent, handle, and combat IAS by taking measure such as mitigation, aiming to maintain a healthy biodiversity, human safety, and sound development of agriculture, forestry and fisheries.

Article 2

1) The definitions of the terms used in this By-Law are as follows:

i. **Invasive alien species:** refer to species introduced to areas outside their native range that have become successfully established and cause substantial impacts on the new environment.[1]

ii. **Native/ Indigenous:** means a species, subspecies, or lower taxon, occurring within its natural range (past or present) and dispersal potential (i.e. within the range it occupies naturally or could occupy without direct or indirect introduction or care by humans.[2]

iii. **Alien/ Non-native:** are animals, plants or other organisms introduced by humans, either intentionally or accidentally, into areas outside their natural range. Some of these species become established and negatively impact native biodiversity.[2]

iv. **Introduction:** means the movement, by human agency, of a species, subspecies, or lower taxon (including any part, gametes or propagule that might survive and subsequently reproduce) outside its natural range (past or present). This movement can be either within a country or between countries. [2]

v. **Intentional introduction:** An introduction made deliberately by humans, involving the purposeful movement of a species outside of its natural range and dispersal potential. (Such introductions may be authorized or unauthorized). [2]

vi. **Unintentional introduction:** An unintended introduction made as a result of a species utilizing humans or human delivery systems as vectors for dispersal outside its natural range. [2]

vii. **Introduced species:** Any species transported intentionally or accidentally by a human-mediated vector into habitats outside its native range.[3]

viii. **Casual:** Alien plants that may flourish and even reproduce occasionally outside cultivation in an area, but that eventually die out because they do not form self-replacing populations, and rely on repeated introductions for their persistence.

ix. **Naturalized:** A non-native species that does not need human help to reproduce and maintain itself over time in an area where it is not native.

x. **Containment:** Application of phytosanitary measures in and around an infested area to prevent spread of a pest. [4]

xi. **Contamination:** Presence in a commodity, storage place, conveyance or container, of pests or other regulated articles, not constituting an infestation. [4]

xii. **Control (of a pest):** Suppression, containment or eradication of a pest population. [4]

xiii. **Entry (of a pest):** Movement of a pest into an area where it is not yet present, or present but not widely distributed and being officially controlled [4]

xiv. **Eradication:** Application of phytosanitary measures to eliminate a pest from an area. [4]

xv. **Establishment:** The process of an alien species in a new habitat successfully producing viable offspring with the likelihood of continued survival. [1]

xvi. **Monitoring:** An official ongoing process to verify phytosanitary situations. [4]

xvii. **Release (into the environment):** Intentional liberation of an organism into the environment. [4]

xviii. **Risk analysis:** (1) the assessment of the consequences of the introduction and of the likelihood of establishment of an alien species using science-based information (i.e., risk assessment), and (2) to the identification of measures that can be implemented to reduce or manage these risks (i.e., risk management), taking into account socio-economic and cultural considerations. [4]

xix. **Risk assessment**: The evaluation of the likelihood of entry, establishment or spread of a pest or disease within the territory of an importing Member according to the sanitary or phytosanitary measures which might be applied, and of the associated potential biological and economic consequences; or the evaluation of the potential for adverse effects on human or animal health arising from the presence of additives, contaminants, toxins or disease-causing organisms in food, beverages or feedstuffs. [5]

xx. **Spread:** Expansion of the geographical distribution of a pest within an area.[4]

xxi. **Adverse Effects on Ecosystems:** adverse effects on ecosystems, human safety, or agriculture, forestry and fisheries.

xxii. **Exotic pet:** is an animal that is native to a foreign country or of foreign origin or character, is not native or indigenous to Palestine, or was introduced from abroad. [6]

xxiii. **Pathway:** any means that allows the entry or spread of a pest. [4]

xxiv. **Vector: a**ny living or non-living carrier that transports living organisms intentionally or unintentionally.[4]

Notes:

[1] Definition adopted from CBD

[2] Definition adopted from IUCN

[3] Definition adopted from ICES

[4] Definition adopted from IPPC

[5] Definition adopted from WTO

[6] https://definitions.uslegal.com/e/exotic-animal/

b) Chapter 2

Measures to Prevent or Minimize Unwanted Introductions

Article 3:

1) The Environment Quality Authority (EQA), in coordination with the Ministry of Agriculture (MoA), and any relevant governmental body shall prepare a "Basic Policy" for preventing the Adverse Effects on Ecosystems caused by IAS.

2) The "Basic Policy" shall include:
   i. A framework for preventing the Adverse Effects on Ecosystems, habitats, Biodiversity and public health.
   ii. A national checklist of IAS, and a clear criterion for their selection.
   iii. Protocols for handling IAS and its Adverse Effects on Ecosystems habitats, Biodiversity, and public health.
   iv. Principles for mitigation/ eradication and control of IAS by relevant governmental bodies and other entities.
3) EQA, in coordination with MoA, and other relevant governmental bodies (hereafter Competent authorities) shall announce the "Basic Policy" stipulated under paragraph 1, and update its content annually.

Article 4:

1) Competent authorities shall prohibit members of IAS listed in Article 3 (2,ii) from being imported to the State of Palestine or traded between the State of Palestine and another country.

c) Chapter 3

Monitoring and Early Warning System

Article 5:

1) Raising of IAS is prohibited other than the following cases:
i. A permission is obtained from the competent authorities.
ii. In the case of unavoidable reason (capture, treatment for mitigation) permitted by the competent authorities.
iii. Scientific research after obtaining permission from the competent authorities.
2) Obtaining permission from the competent authorities is achieved through submitting an application for the competent authorities.
3) A risk analysis study and environmental impact assessment must be carried out prior to submitting the application for any IAS.
4) In case of granting permission, the competent authorities must provide conditions to prevent Adverse Effects on Ecosystem, habitats, Biodiversity and public health. by IAS.

5) In case of a violation for the permission's conditions, the competent authorities shall order a correction to the methods of raising, or cancel the permit to prevent the Adverse Effects of IAS.

Article 6:

Importing of IAS is prohibited, unless a permit is obtained under Article 5(1) of this Law.

Article 7:

Transferring IAS is not allowed, unless permitted by competent authorities for reasons stated in Article 5 (1) of this Law.

Article 8:

Releasing of raised, imported, transferred IAS is prohibited.

Article 9:

The competent authorities required to enforce this Law may visit permitted facilities handling IAS for inspection, documentation, question relevant persons, or any relevant matter.

Article 10:

It is strictly prohibited to introduce, raise, or transfer, IAS in all protected areas, Key biodiversity areas, and Rich biodiversity sites in the State of Palestine

Article 11:

1. The competent authorities shall perform annual surveys in the State of Palestine detect an intentional or unintentional introduction, spread, or transformation of IAS.
2. The competent authorities shall formulate emergency plans for coping with IAS and its Adverse Effects on Ecosystems.

d) Chapter 4

Mitigation Measures of IAS

Article 12:

In the event of "Adverse Effects on Ecosystem" has occurred by AIS, the competent authorities shall conduct mitigation measures following the rational in Chapter 3 of this law.

The competent authorities shall announce:

i. Type of IAS, mitigation strategy, or any relevant matters.
ii. Mitigation area, and execution period.

Article 13:

1. In case mitigation action to the Adverse Effects on Ecosystem caused by IAS is within private land ownership, the competent authorities shall authorize conducting the mitigation process.
2. The authorized staff must notify the property owners in advance about the mitigation acts.

Article 14:

In case the competent authorities proves that there is a person who has caused the introduction, spread, or transformation of IAS, the government may oblige the person to bear the expenses of mitigation either partially or fully.

Article 15:

1. Relevant public entities, or eradication experts may obtain special permits from the competent authorities to perform mitigation acts upon an official announcement from the competent authorities.
2. The competent authorities may request to submit reports on performed mitigation or any relevant data.

e) Chapter 5

Exotic Pets

Article 16:

1. Abandoning or intentionally releasing exotic pets is prohibited in the State of Palestine.
2. Pet shops must inform costumers of this prohibition.
3. In case a person intentionally releases an exotic pet to the wild, then the competent authorities may issue a penalty.
4. The competent authorities shall establish a recovery system for unwanted exotic pets.

f) Chapter 6

Scientific Research, Capacity Building, and Public Awareness

Article 17:

Competent authorities shall encourage capacity building for relevant stakeholders to design, implement, and enforce requirements to prevent introduction of IAS. Moreover, building capacity towards mitigation measures, and best national and international practices.

Article 18:

Competent authorities shall encourage research about the Adverse Effects on Ecosystems caused by IAS, mitigation measures, and promote any relevant knowledge.

Article 19:

Competent authorities shall perform educational activities, and public relation activities to amplify the knowledge about the Adverse Effects of Ecosystems caused by IAS.

g) Chapter 7

Penal Provisions

Article 20:

Every person/ corporate who caused any environmental damage as a result of an act or negligence in violation to the provisions of this law or any relevant international agreement in which Palestine is a party thereto shall be bound to pay the appropriate compensations in addition to the penal responsibility which is provided for in this law.

Article 21:

Whoever violates the provisions of articles 5, 6, 7, 8, 10, and 16 (1) of this law shall be penalized by a fine of not less than one thousand (1000) Jordanian Dinars and not exceeding five thousand (5,000) Jordanian Dinars or the equivalent thereto in the currency in legal circulation and imprisonment for a minimum period of six months and not exceeding three years or by one of these two penalties.

h) Chapter 8

Regulations and Final Dispositions

Article 22:

According to the provisions of the law, the international or regional conventions and agreements as well as the provisions of the international organizations in which Palestine is a party or any other laws relating to IAS, which are valid in the Palestinian territories, shall be considered as a complementary part to this law unless it has been expressly provided otherwise.

Article 23:

The Competent authorities must issue the guidelines relating to the enforcement of this Law within three months of the Law's publication date.

Article 24:

The current law becomes effective six months after its publication date.

Article 25:

The Council of Ministers is in charge of carrying out the rules of the current legislation.

A capacity building plan for individuals, organizations, and communities

According to the United Nations Development Program "capacity building" can be defined as the: "process that supports the initial stages of building or creating capacities and assumes that there are no existing capacities to start from. Capacity building can be threefold, as it is individual, organizational and systemic. Its further accounts for developing technical and scientific knowledge and their relevant competencies"[1]. Capacity building is considered as an important component for sustainable management of invasive alien species (IAS). Moreover, all biodiversity related international conventions, protocols, and treaties emphasize on the importance of capacity building to achieve their objectives.

Capacity building is an essential component in combating IAS to ensure successful implementation of national and international related guidelines and regulations, and to increase the long-term impact of sustainable management of IAS. Moreover, capacity building enhances cooperation between stakeholders, and improves investment in the management plans against the adverse effects of IAS. Capacity building programs also increase institutionalization of responsible approaches to biological control and management which can be used in other pest control problems as well.

This document uses the concept "capacity building" for the collective ability to successfully manage IAS in Palestine. Nevertheless, it is important to clarify that each individual/ organization/ community will have special capacities that may differ. Practitioners may need to improve their knowledge, skills, and confidence. On the other hand, organizational capacity will focus more towards developing policies, procedures, and registries. Capacity building within communities, attention will be on creating groups, increasing access to information, as well as providing tools for collecting data.

For effective capacity building on IAS, six components need to be included in any offered program (Figure 2); information/data, technology, skills, project management, stakeholders support, and funding.

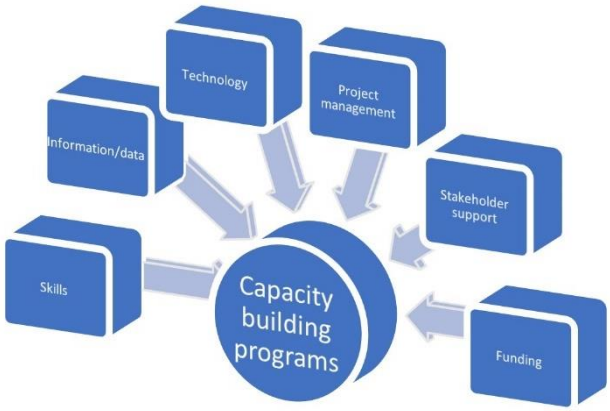


Figure 2: Six components of a successful capacity building program

[1]Capacity Development: A UNDP Primer. United Nations Development Program. 13 October 2009.

In Palestine, there is a serious need to address capacity gaps in the detection, prevention, early detection and rapid response, control, restoration, management plans, and in raising awareness related to IAS at the personal, community, and organizational levels. The following actions should be prioritized to effectively manage IAS.

A. Capacity actions targeting individuals:

Capacity actions targeting individuals aim to raise knowledge, skills, and confidence with respect to IAS identification, control, and management. In general, targeting individuals is the least time consuming, and least complex. Methods to build capacity within individuals can include; one to one learning, communicating with experts, access to peer review publications, training sessions, workshops combined with site visits, exchanging expertise with peers, networking both at the regional and international levels, and replicating good practices.

Targeting key individuals to provide capacity concerning IAS may include political leaders, rangers, farmers, scientists, researchers, university postgraduates, managers of relevant organizations, and environmental decision makers.

Competent authorities are recommended to take the following actions:

1. Find taxonomists of various taxa that are able to accurately identify IAS, and experts in the fields of its control and management in Palestine.
2. Create a registry for relevant taxonomists and experts to be kept with competent authorities.
3. Ensure the registry of the pool of experts is kept up to date regularly.
4. Organize trainings for core capacity and diagnostics, taxonomists and experts and individual development in the field of IAS, especially related to new technologies and best practice methods.
5. Organize trainings to increase risk assessment capacities.
6. Invest in human capacity to increase research related to IAS.
7. Invest in the pool of experts' registry to support national level institutional capacity.

B. Capacity actions targeting organizations at the national and regional levels:

Capacity building at the organizational level is the measurable improvement in the organization's mechanisms and procedures in order to increase its ability to identify, control, combat, and manage IAS. Organizational capacity building is considered to be more complex and time consuming in comparison to increasing capacities of individuals. Methods that are usually used to increase organizational capacities include; improving the process and guidelines relevant to IAS, using a monitoring & evaluation toolkit, creating templates, facilitating access to experts in the IAS field, improving access to regional and international networks, resources, and information.

Moreover, enabling a supportive policy, legal, and institutional frameworks both at the national and regional levels are the most complex and time-consuming steps towards building capacity in the country. To achieve this target national, regional, and international networks must be formed, alongside with creating supportive frameworks for coordination. Furthermore, regional guidelines must be created, and an easy access to resources and best practices must be shared with all partners among the networks.

The following actions are recommended:

I. At the national organizational level:

1. Invest in capacity building among national IAS competent authority staff and other stakeholders for a reliable taxonomic identification of IAS.
2. Create the national list of IAS and their distribution
3. Create and update periodically the national list of IAS of highest concern.
4. Periodically publish guides and manuals for identifying IAS.
5. Establish procedures on collecting and analyzing existing data on IAS, and circulate information to relevant stakeholders.
6. IAS competent authorities need to create inventories for IAS, and identify existing expertise and existing research for each species.
7. Establish an online "Central Information System on IAS" to include IAS inventories, that is managed by "IAS competent authorities" as a national focal point and coordinating agency.
8. Keep IAS inventories up-to-date, including its adverse effects on biodiversity, pictures, control procedures, and identification tools.
9. In case of a new IAS detection, IAS competent authorities need to collect and circulate data quickly and efficiently including risk assessment, and recommend response actions to stakeholders.
10. Organize training workshops for border inspectors to build/ increase capacity on imported IAS, pathways, and vectors.
11. Increase risk assessment capacities for IAS competent authorities and relevant organizations.
12. Strengthen legislative tools related to IAS (see section "legal part-p. 82"), and increase capacity of relevant governmental departments, and operational capacities to implement the policies.
13. Clearly define "who-does-what" among IAS competent authorities to prevent any delays in response towards new invasions.
14. Invest in "centers of excellence" to do research on the biology of invasion, threat, risk analysis, and innovative solutions.
15. Strengthen the technical capacity of the "Plant Quarantine and Phytosanitary Department" to prevent the entry of IAS to Palestine, emphasizing on the fact that IAS does not impose a threat on agriculture only, but impact natural environments and biodiversity as well.

16. Strengthen the technical capacities of IAS competent authorities on the protocols of early detection and rapid response for newly introduced IAS.
17. Promote cross-sectoral cooperation and exchange of expertise by involving scientists, environmental managers, citizens in invasive species targeted programs.
18. Organize training programs to cover all aspect of IAS (identification, management, fundraising, policies, and best practices).
19. Keep an up-to-date national database with all invasive species projects (aim, outcomes, lessons learnt, and technical information).

II. At the regional/ international organizational levels:

1. IAS competent authorities identify relevant regional/ international expertise and networks.
2. Integrate IAS inventories with regional/ international databases regularly.
3. Join global and regional invasive species networks to exchange skills, distribution lists, species lists, and other experiences.
4. Initiate the creation of a regional initiative in the East-Mediterranean region for invasive species management.
5. Benefit from regional initiatives in creating collaborative action plans to limit the entry of new IAS, and cooperate on optimal management strategies.
6. Engage with global mechanisms to achieve coordination between regional networks and agencies.

C. Capacity actions targeting communities:

In order to successfully manage IAS in Palestine, community involvement is of high importance. Research and policies alone are not sufficient in implementing IAS's management plans. Full participation of the communities in the IAS management can be achieved by enabling them, with the proper skills, tools, information, and an efficient and effective reach-out to the competent authorities. Building community capacity requires:

1. Involve and educate community members and leaders about IAS.
2. Create an interactive mobile application to allow citizens to identify and report IAS.
3. Provide information (leaflets, posters, website, mobile application, etc.) about IAS and its adverse effects on biodiversity, with special focus on various IAS in the community's surroundings.
4. Create "community IAS groups" (youth, women, scouts, environmental clubs, farmers, etc.) and provide them with skills, information, and resources in order to act effectively.

5. Provide each community IAS group with a focal point to link the community to relevant decision makers.
6. Organize workshops and trainings for community IAS groups.
7. Incorporate “citizen science” concept in the management plans of IAS, and provide skills to community members. Validity of information obtained by “citizen science” must be from experts.

The National Palestinian Early Detection and Rapid Response Plan

Preventing the introduction of IAS to Palestine is the most effective action to eliminate their negative impacts on biodiversity, environment, and health. Nevertheless, in our modern world, vectors and pathways for IAS's introductions are very diverse, therefore Early Detection and Rapid Response (EDRR) national plans are important. It is agreed by experts that EDRR efforts are the most cost-effective, ecologically viable, and efficient to control new emerging IAS species before their reproduction and spread beyond their access point. Applying EDRR actions serve to increase the possibility of discovering new invasions before their establishment, as well as, identify, eradicate, and control new IAS in a country.

The adoption of EDRR plan is not only a national need. The ninth Conference of the Parties of the CBD (Bonn,2008), recommended in its Decision *IX/4* that "parties should collaborate on the development and use of early warning systems, including networks and focal points, and on the development and use of rapid response mechanisms" [1]. The need to adopt an effective early warning system and rapid response was also endorsed as a priority by the G8 Environment Ministers Meeting in the "Charter of Syracuse/ 2009, Italy" [2].

In Palestine the capacities to detect and react effectively and rapidly to new IAS intrusions are very limited. Up to this point, there is no national plan to discover and promptly respond to new invasions in the country. Moreover, in most of the cases, measures are taken to control IAS after the EDRR plans are not feasible anymore. Therefore, creating, adopting, and implementing an EDRR national plan is extremely needed to detect and prevent new IAS incursions (Figure 3). It is also essential for a speedy risk assessment, and finally an efficient response to be implemented when needed.

Figure 3: General scheme of a successful EDRR plan

The aim of the EDRR Palestinian national plan for IAS is to deliver a framework for stakeholders to effectively address new incursions, provide an early detection mechanism, reporting recommendations, procedures for identification and registering for new invasions, verification methods, rapid assessment and response procedures, and dissemination of data to stakeholders.

The proposed national plan will focus on creating an effective EDRR system by following six steps; starting by early detection, followed by identification, alert screening, risk assessment, rapid response, and ends by monitoring and reassessing the whole process. The plan will also emphasize on the importance of an efficient managerial practice, as well as, reporting and

outreach to adjacent programs. The Palestinian national EDRR can be summarized in Figures 5 & 4:

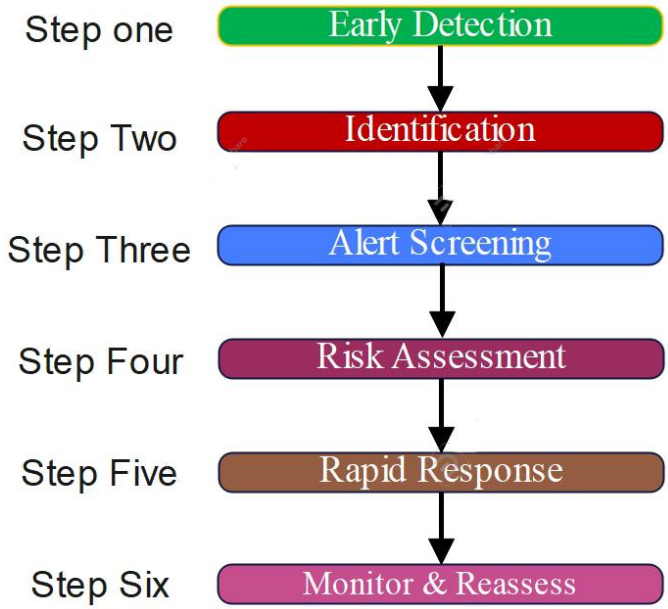


Figure 4: The six building block steps in the Palestinian National EDRR plan

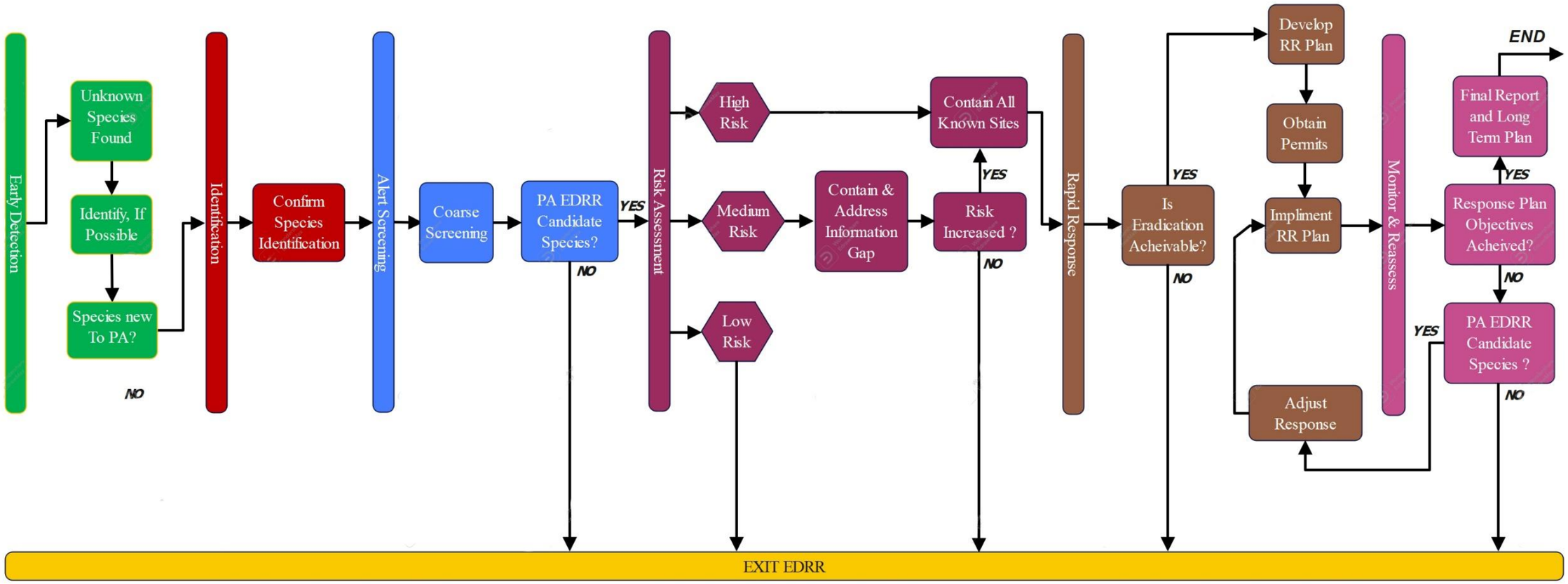


Figure 5: Overview of the Palestinian National EDRR plan for invasive alien species

1. Terminology:

1. EDRR: a framework designed to respond to biological invasions through a coordinated system of surveillance and monitoring activities; diagnosis of invading species; assessment of risks; circulation of information, including reporting to competent authorities; and identification and enforcement of appropriate responses [3].
2. Response: is the process of reacting to the detection once the organism has been authoritatively identified and response options have been assessed [4].
3. Alert list (alarm list): the main purpose of this list is to achieve early warning and draw the attention to IAS that are not yet present in Palestine, but already present in neighboring areas therefore imposing a risk.
4. Watch list: a list of alien species that are present only in a limited range and are considered to potentially pose risks to the invaded area and for which it is recommended to monitor arrival, expansion and impacts, and/or application of prevention measures.
5. Black list: a list of alien species that have been shown through risk assessment to pose risks to the environment, economy or human well-being [3].
6. Eradication: application of phytosanitary measures to eliminate a pest from an area [5].
7. Containment: application of sanitary measures in and around an infested area to prevent spread of IAS.
8. Control: suppression, containment or eradication of an IAS population.

2. Logical framework for EDRR plan:

2.1 Step 1 – Early Detection (surveillance and monitoring):

Early detection can be defined as the process of finding new invasions before they are established, and dispersed. As a result, early detection is a vital step towards effective eradication and containment. As can be seen in figure 5 & 6, the first step in the early detection is surveillance and monitoring. Surveillance can be achieved passively or actively. Passive surveillance occurs when an observer accidently discovers a new incursion, while active surveillance is a programmed activity aiming to identify new invasions in a country. Active surveillance programs are structured and usually are implemented at possible IAS pathways, such as borders, quarantine, etc. On the other hand, monitoring programs aim to gain better understanding of the ecology, distribution, spread, and feasible management of the new invasion. Monitoring provides robust scientific information to facilitate the decision-making process.

Whenever a new invasion is detected either actively or passively, a report should be submitted to the competent authorities. We recommend establishing an open access online platform for reporting purposes that could be linked with the competent authority's official website. On this platform, pictures of the new invasion, GPS location, population size, or any relevant data should be reported to help in the identification proceeding step.

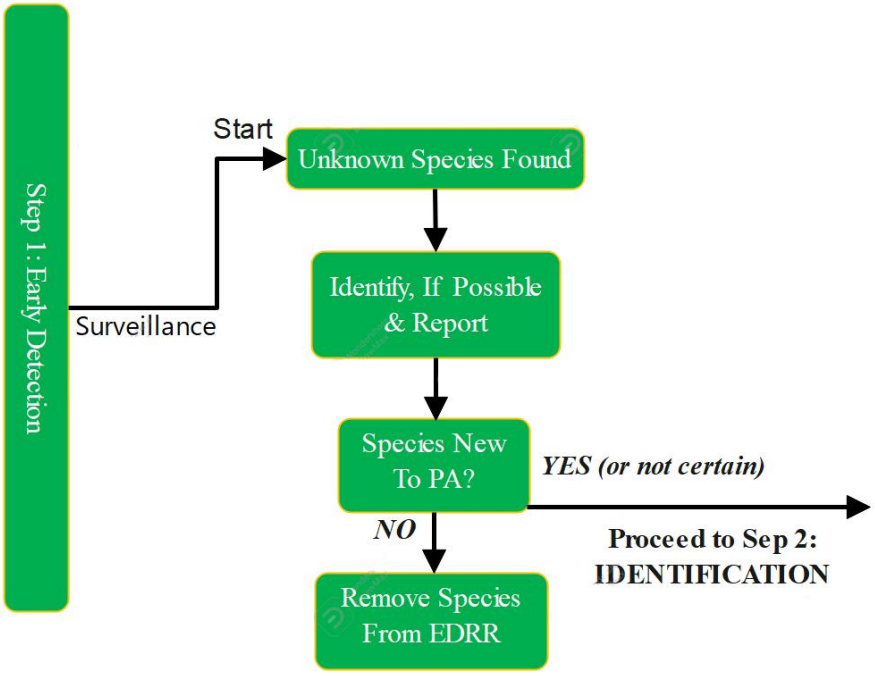


Figure 6: First step in the EDRR- Early Detection

Once a report has been submitted, the competent authorities will attempt to initially identify the new invasion. Identification of the invading species could be done with the help of:

1) The pool of national taxonomists and experts registered in the competent authority's registry.
2) Looking into various taxonomic species guides and manuals.
3) Searching in trusted online databases (IUCN/SSC, CABI, ISSG, DAISIE, GISD etc.)

The outcome of the initial identification assessment will result in one of the following outputs:

a. The species is identified and is not new to Palestine, then the incident is added to the national invasive species database, and the species is removed from the EDRR plan.
b. The species is a new invasive species to Palestine, then all gained information is collected, the species moves to step 2 in the EDRR plan.
c. The species was not identified, then the species proceeds to step 2 in the EDRR plan.

Recommendations concerning the "Early Detection" step 1:

1. Creating a national "surveillance department" to follow up with new invasions, and periodically collect relevant data from experts, research institutes, scientific journals, grey literature, etc. and registering relevant information into the "national surveillance and monitoring database". The "surveillance department" can be jointly run by the EQA and MoA.
2. Creating an online user-friendly database for reporting purposes.
3. Developing a national alarm list, watch list, and black list for rapid detection (see Figure).

4. Regular surveillance for high-risk areas (species on the watch list, main entry points, etc.).

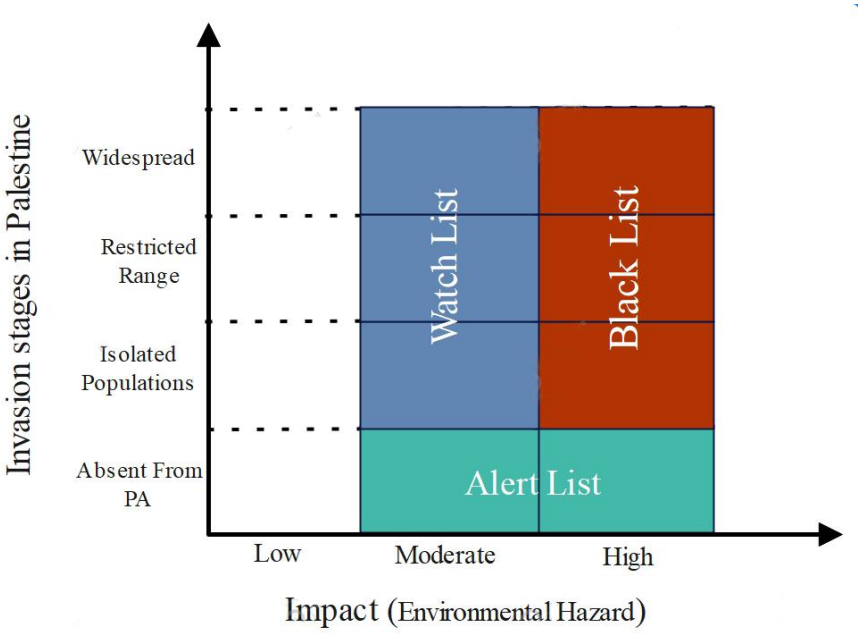


Figure 7: List system to identify the threat of IAS on Palestine

5. Regular surveillance in highly disturbed areas (quarries, construction areas, road sides, national and private nurseries, and main transboundary watersheds and streams.
6. Regular surveillance in ecologically sensitive areas.
7. Integrating monitoring programs and their outcomes into the "national surveillance and monitoring database".
8. Encourage monitoring programs in pathways, high risk areas, and vulnerable sites.
9. Ensure sharing data with neighboring countries through regional and global networks.
10. Organize capacity building trainings for officers at points of entry, quarantine staff, rangers, farmers, gardeners, etc. to detect and report new invasions.

Timeline:

Observers must report about new incursions as fast as possible via the online reporting platform database. Initial identification of the species should not exceed one week.

2.2 Step 2 – Identification:

Step 2 (figure 6) is reached either if the new incursion has been initially identified, or no identification could be found in step 1. The identification must be verified by an expert taxonomist (botanist, ornithologist,

mammologist, entomologist, herpetologist, etc.). This step may be very challenging, as IAS can arrive in various life stages (eggs, seeds, spores, larvae, etc.), taking into consideration that there is a dearth of Palestinian taxonomists in several fields. In many cases classical taxonomic identifications are not adequate enough, therefore DNA barcoding may be necessary to identify new invaders.

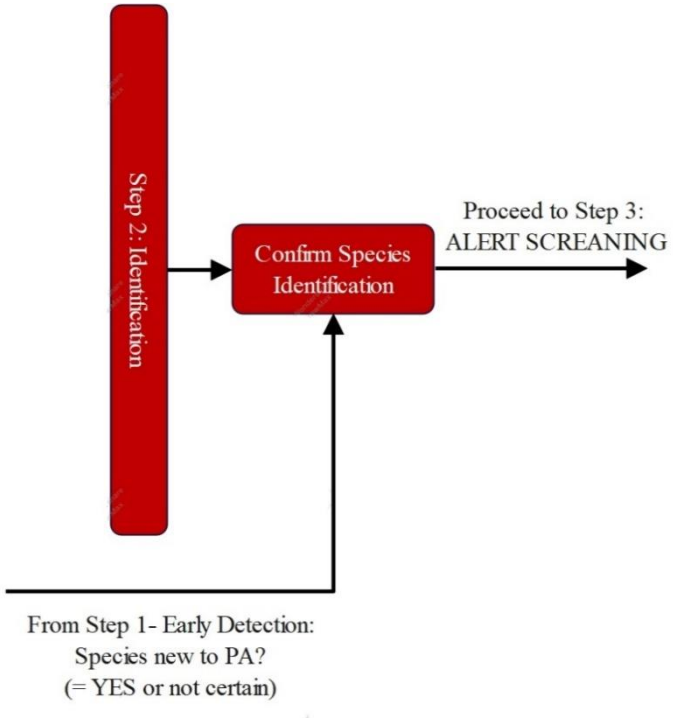


Figure 8: Second step in the EDRR- Identification

In case the identified species is an IAS but not new to Palestine, then the new record must be entered to the "national surveillance and monitoring database". Furthermore, the species must be removed from the EDRR process, and not to proceed to step 3. If the species is identified as a new IAS to Palestine, then the species must move to step 3 in the EDRR process.

Recommendations concerning identification – step 2:

1. Create an IAS national body of experts to help authorities with identification when needed.
2. Verify identified species with existing databases from the region/ globe.
3. Keep the list of national taxonomists up-to-date.
4. Circulate data concerning IAS regularly among competent authority and stakeholders to increase existing capacities.
5. Offer scholarships for graduate students to specialize in taxonomic identifications.

Timeline:

Approximately one week is needed to verify the identification of the new invasion. In some cases, identification may be more difficult, or no taxonomist expert is available, therefore verification could take up to one month.

2.3 Step 3 – Alert Screening:

The alert screening step aims to coarsely assess the risk of a species (figure 7). It is an intermediate step to evaluate whether to move the EDRR towards step 4 and perform a complete risk assessment process, or to exit the EDRR and move onto a management plan instead.

In this step the following components are coarsely investigated:

1. Determining the biology and ecology of the new incursion.
2. Identifying the distribution of the new IAS nationally and worldwide.
3. Assess the impact of the new IAS on similar habitats in the world.
4. Possible negative effects on biodiversity, environment, health, and economy.
5. Possible immediate eradication/ containment.

Simultaneously, a survey is performed to assess the population size, spread, habitat, vectors, and pathways of the new incursion. Taking into consideration the answers gained through performing the alert screening, a suitable eradication method is found. After knowledge of the sites of the incursion, the species will remain in the EDRR plan and proceed to the next step.

<u>Recommendations concerning alert assessment – step 3:</u>

1. The alert screening step should be performed in a transparent and speedy matter for all newly identified IAS in Palestine.
2. Competent authorities to develop and regularly update coarse screening mechanisms and protocols.
3. Organize trainings concerning "alert screening" mechanisms and protocols to key personnel and stakeholders.

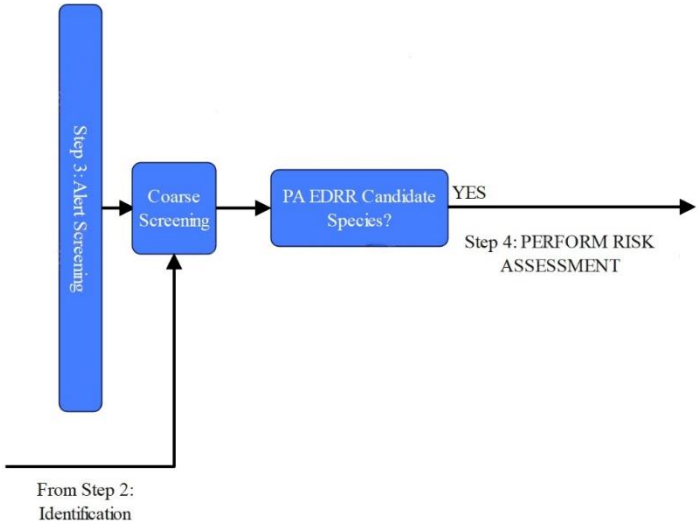


Figure 9: Third step in the EDRR plan – Alert Screening

Timeline:

Both the survey and the coarse assessment process must be completed in two weeks.

2.4 Step 4 – Risk Assessment:

In this step, a deep evaluation of the risks associated to the introduction of the new IAS are assessed, such as the chances of the new incursion to become established and dispersed (figure 8). Moreover, the threats the new invader imposes on the environment, economy, and health are rigorously evaluated. Step 4 requires a detailed process, therefore demands a substantial investment in experts, funds, and time.

The outcome of the risk assessment step will result in one of the following outcomes:

a. **Low risk:** the new invasive species exits from the EDRR process and is diverted towards management actions.
b. **Medium risk:** the new invader continues in the EDRR plan, with addressing any missing information, and reevaluating its risk. In case the species still imposes medium risk after reassessment, the competent authority will decide if to move forward to step 5 in the EDRR plan, or to direct the species into management actions rather than rapid response. This may depend on the availability of financial resources, treatments, and required expertise.
c. **High risk:** the new IAS proceeds to step 5.

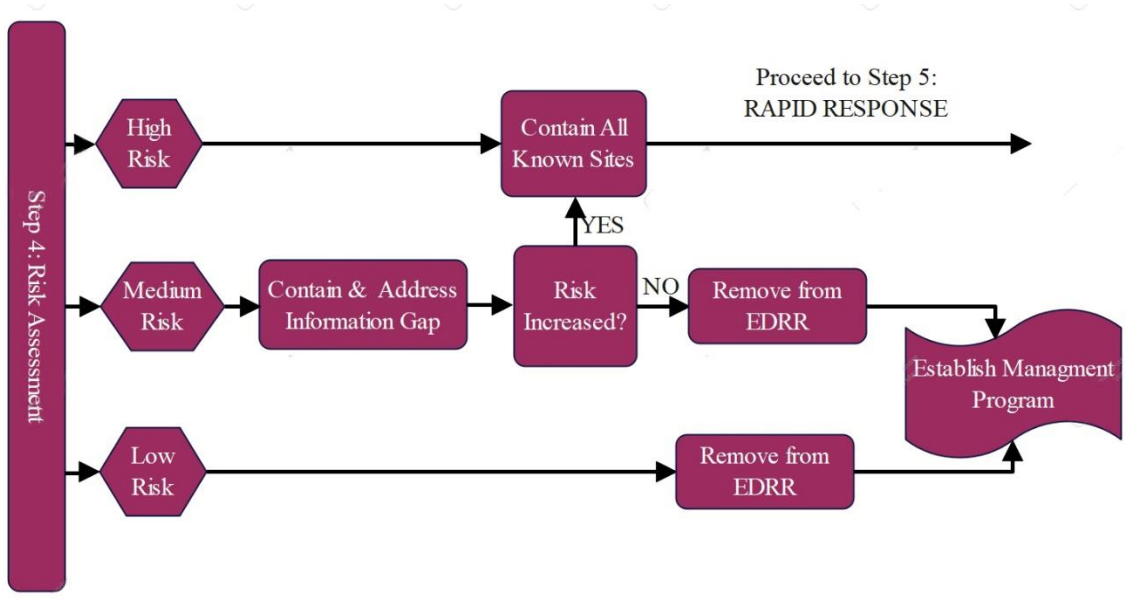


Figure 10: Fourth step of the EDRR plan – Risk Assessment

Recommendations concerning risk assessment – step 4:

1. Competent authorities are recommended to standardize the risk assessment procedures and protocols.
2. Involve all stakeholders in updating risk assessment protocols periodically.
3. Conduct capacity building programs targeting relevant stakeholders concerning IAS risk assessment protocols and procedures.

Timeline:

It is advised that step 4 shall be performed in a 3-week time frame.

2.5 Step 5 – Rapid Response:

As the new incursion is assessed of having a high risk after step 4, then a suitable rapid response is to be decided in step 5 (figure 9). In this step, the feasibility of eradication is studied (treatment availability, cost, negative consequences, etc.), followed by developing a response plan, and obtaining all needed permits for the implementation activities.

It is advised to form a "*rapid response team"* for each incursion depending on the location in the country, taxonomic group, species, habitat, etc. Referring to the IAS-bylaw in section "Mitigation Measures of IAS", eradication permits must be obtained from the competent authorities prior to the implementation action. If the new incursion happens to be in a privately owned land, landowners must be informed ahead of time. The team must ensure safety standards after the treatment is applied. The customized rapid response plan should also include pre-treatment assessment, treatment protocol, and monitoring timeline after eradication. The team may also recommend "containment" temporary measures until the rapid response plan is finalized. If eradication is not feasible the team may choose to control, contain, or no action to be taken for the new incursion.

In general, eradication is the most efficient action especially when the new IAS's populations are still small, or in an isolated ecosystem. Eradication needs shorter time therefore is more cost-effective than control measures.

When eradication is not possible, the team may recommend long-term control instead. Control activities aim to decrease the abundance and density of the new incursion to minimize its impact. Control activities may include chemical, mechanical, and biological means, or other integrated management techniques.

Containment is another possibility, which aims to limit the spread of the new incursion within a limited location by using natural or artificial barriers such as fencing. This method is usually recommended when the new IAS's population is small.

Finally, the team may decide not to take any action to combat the new incursion. This decision is chosen when all the methods described above are not feasible, or if they prove to be technically or socially unacceptable.

The possible outcomes of the rapid response step are:

1. Eradication is doable, the rapid response plan is established, permits are obtained, and the treatment is implemented. The new incursion moves to the next step in the EDRR plan.
2. Eradication is not possible, then the new incursion exits the EDRR plan, and is directed towards a management plan instead.

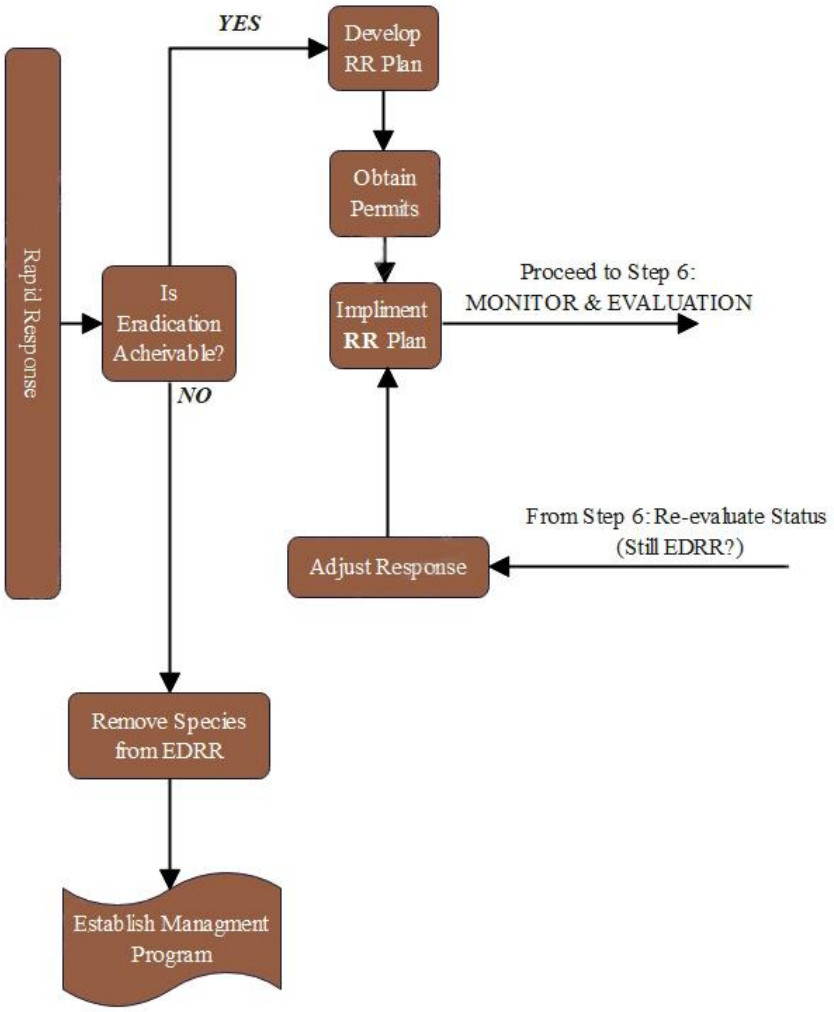


Figure 11: Fifth step of the EDDR plan – Rapid Response

Recommendations concerning Rapid Response- step 5:

1. The presence of proper legislations to support the rapid response process.
2. Secure funding for rapid response actions when needed.
3. Prepare ahead rapid response actions for species found on the alert list of the country.
4. Organize capacity building trainings on eradication, control, and containment techniques.
5. Prepare general plan for eradication, containment, and control of groups of species similar in characteristics (invertebrates, small mammals, large mammals, birds, freshwater fish, etc.)

Timeline:

This step is dependent on the difficulty of the response, and the time required for obtaining permissions.

2.6 Step (6) – Monitor and Reassessment:

After the eradication of the new incursion is performed in step 5, the rapid response team must apply monitoring and reassessment procedures to secure that the intended objective of the EDRR plan has been achieved (figure 10). Throughout the monitoring and reassessment procedures, information is collected to measure the efficiency of the rapid response step, and adjust the response if needed. The reassessment procedure also looks into the strengths and weaknesses of the EDRR plan for dealing with future similar incursions.

The outcomes of the monitoring procedures decide whether the implementation of the rapid response plan was effective by looking into the changes in the new incursion's populations size with time, and treatment efficacy. If the outcomes were not satisfactory to the team, reevaluation of the response takes place to decide if the incursion is still an EDRR candidate using the assessment protocol previously used. Results of the monitoring and reassessment procedures need to be included in the final report for each response.

There can be three possible outcomes out of the monitoring and reassessment step:

1. The eradication process was successful, then the final report is prepared and the team prepares a long-term monitoring plan.
2. The eradication was not successful, then the species is removed from the EDRR plan and is referred to a management plan with the competent authorities.
3. Eradication in progress, the team reevaluates the treatment to the incursion, permits for eradication are renewed, and the species stays in the EDRR loop as can be seen in Figure 10.

Recommendations for step 6 – Monitoring and Reassessment:

1. The competent authority must enforce a mandatory detailed report to be submitted from the rapid response team during and after the eradication process.
2. The competent authority should create a clear reporting mechanism to enhance the information flow from the rapid response team.
3. Make sure to update gained information from step 6 in the regional and global registries.

Timeline:

The time needed for monitoring and reassessment varies depending on the species and the eradication activities. Monitoring should take place at least once a year at each site.

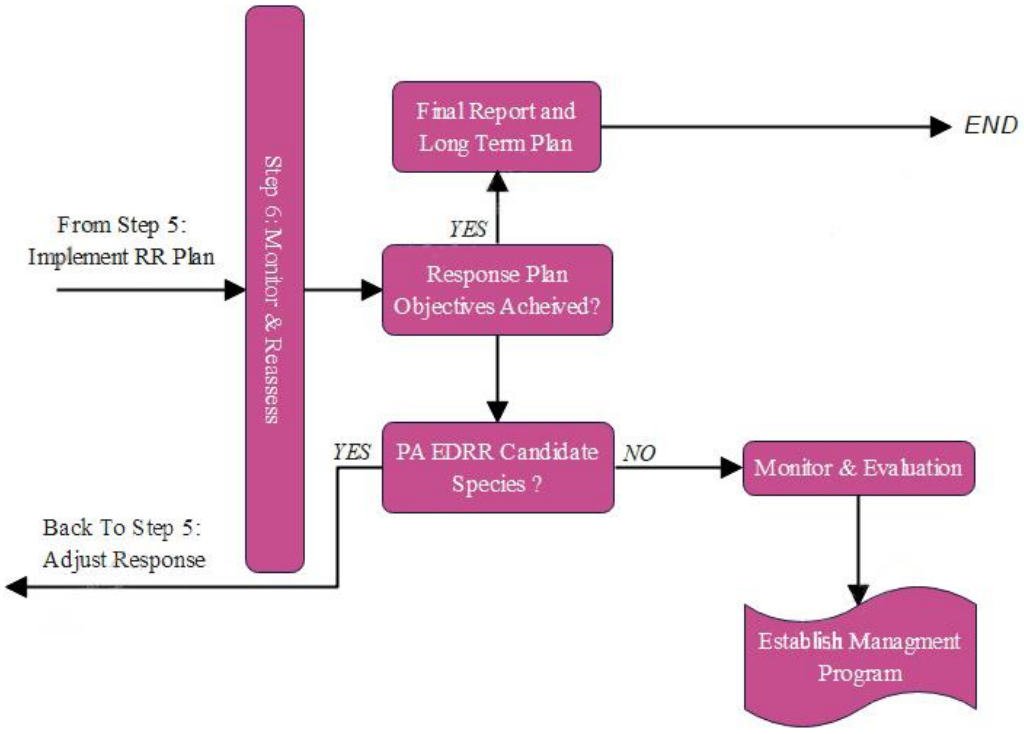


Figure 12: Sixth step of the EDRR plan – Monitoring and Reassessment

3. Reporting in the EDRR plan:

As highlighted, all through the Palestinian national EDRR plan discussed above, regular reporting is an essential component. Formal reports mean to inform governments, stakeholders, landowners, regional and international partners on the outcomes of the various EDRR plans.

The following reports are suggested to accompany the EDRR plan:

1. **Annual EDRR report:** competent authorities will prepare a report for all the EDRR running programs in Palestine including information on the IAS, progress in each step of the EDRR plan, practical recommendations, and best practices. The report should be circulated to stakeholders, research institutes, quarantine officers, taxonomists, etc.
2. **Rapid Response report:** this report must be prepared at the end of the EDRR plan for each species. The report needs to include the eradication method used, the name of the rapid response team, timelines, monitoring and reassessment outcomes. The report may also include recommendations for future EDRR plans as well.
3. **IAS status:** as described above, it is of high importance to update the status of new species on "national surveillance and monitoring database" regularly.

Education, Public Awareness, and Outreach

1) Background

Human movement and transportation comprise a significant pathway for the spread of IAS, therefore peoples' daily activities and habits are fundamental in the IAS issue. The lack of awareness about IAS and their negative impacts, the threats of carrying and introducing them, and the risks they impose is very high. This chapter will present a set of recommendations and activities for education and public outreach in the State of Palestine to address IAS. The current section will provide tools, activities, and guidance for each target audience to educate, spread the word, and involve various sectors within reporting, combating, and managing IAS for the protection of natural ecosystems.

The 6th guiding principle of the CBD (COP6, 2002) is dedicated to education and public awareness. It emphasizes that raising public awareness is crucial to the successful management of IAS. Moreover, it urges Parties to promote education and public awareness of the causes of invasion, and risk associated with their introduction. Additionally, the guiding principle encourages Parties to adopt and activate education and public awareness-oriented programs when mitigation measures are required, in order to engage local communities as well as appropriate sector groups.

There is a pressing need to engage the community, outreach for the public, and construct educational programs to target IAS in Palestine, therefore, these proposed activities will focus on:

1. Raise public awareness about IAS presence, dangers, reduce the spread, and personnel involvement in Palestine.
2. Educate stakeholders, students at various ages, and communities in general about IAS in Palestine, as well as encourage behavior to prevent new introductions.
3. Provide stakeholders with needed knowledge and skills to combat IAS and apply investigation and research concerning IAS by research centers, and to implement IAS action plan.
4. Increase public partnership to successfully implement action items.

The main goal for education and outreach programs is to provide stakeholders and the public with the knowledge, skills, and required actions to manage IAS, and its adverse effects on biodiversity. Moreover, include them in the IAS action plan implementation. The stakeholders include governmental officials, universities, research institutes, relevant NGOs, nurseries, pet trade business, local communities, farmers, etc. It is highly recommended to tackle IAS topic in public awareness programs as an ethical issue, where each person, organization, sector holds responsibility in spreading and controlling IAS, and is conscious about new unintentional introductions of IAS. Moreover, examples of the worse already established IAS in Palestine should

be used to help stakeholders and the public understand the severity of the problem. Positive examples of success management IAS should also be used to guarantee better engagement.

As the Palestinian society can be described as a "young society", youth comprise 30% of the population Special attention should be dedicated to educational programs about IAS in schools and universities.

2) Recommended Outreach Activities:

1. Establish the Palestinian national center for information on IAS, where all information concerning the presence, location, pathway, vectors, and management of IAS is present. It is recommended to also add the Alert list, Watch list, and Black list. The aim of such center is to provide reliable data to the public and stakeholders when needed. The center is also responsible on creating awareness programs targeting stakeholders. The center is recommended to have a website or upload the data on the Palestine's CHM when finalized to disseminate data concerning IAS in an attractive way. Relevant information should be updated periodically to include new invasions, and update management activities. The public and stakeholders must be able to interact with the center to report for new suspected incursions as well. The center should be linked to the EDRR plan already discussed in section "**Logical framework for EDRR plan".**
2. Organize the "Palestinian Invasive Species Week" awareness campaign once a year. The rationale behind the campaign is to increase the public awareness for both stakeholders and people about IAS, and their impacts on agriculture, health, economy, tourism, trade, sustainability, etc. The campaign needs to emphasize motivating each target group about responsible actions towards reporting and preventing new introductions, and how to engage in existing management plans. During this week intensive activities including organizing workshops/ webinars, distributing guides, media coverage through conventional channels & social media, as well as organizing awareness activities in schools and environmental clubs.
3. Use traditional media (television, radio, newspapers, magazines) all year long to educate about nationally present IAS, and its adverse effect on the Palestinian environment. Always add means of communication to report new incursions (toll-free hotline number, website link, mail address). Moreover, utilize social media platforms, which plays a very important role in passing on the message especially to youth. Media coverage concerning IAS can be intensified in national and international environment related occasions such as the Palestine Environmental day (5^{th} of May), World Environment Day (5^{th} of June), International Biodiversity Day (22^{nd} of May), Earth Day (22^{nd} of April), etc. Noteworthy, the need to emphasize that IAS can only be managed through active involvement of each Palestinian living in the country.
4. Use large attractive billboards in highly accessible locations in Palestine to teach about IAS and increase public's perception in this concern.

5. Use public area spaces (nature reserves, gardens, zoos, parks, etc.) to build signs containing information about IAS and their negative impacts on the environment.
6. Print brochures, infographics, and fact sheets about IAS and their management, distribute printed material in environmental events.
7. Collaborate with artists to create artistic projects to promote the idea of preventing IAS introduction, spread, and engage in the management plans.
8. To assess the level of awareness of stakeholders and recognize knowledge gaps about IAS, it is recommended to organize periodic workshops and webinars. This will enable competent authorities to design awareness programs to tackle the right topics in their programs.
9. Integrate education about IAS into already existing programs offered by the EQA and MoA offered to farmers, beekeepers, shepherds, etc.
10. Integrate knowledge about IAS into municipal community-based programs and groups.
11. Educate the environmental policy, environmental inspectors, rangers, costume officers about IAS related legislations and enforcement.
12. Educate stakeholders and the public about using "citizen science" platforms previously discussed in section "Recommended Outreach Activities", to increase their involvement on reporting for new incursions.
13. Organize awareness raising programs for IAS relevant industries such as pet industries, nurseries, and horticulture.
14. Provide information (signs, brochures, media coverage) to hikers, especially in environmentally sensitive areas, urging them to stay on trails, never unfree pets, and remove plant material from shoes before leaving the area.

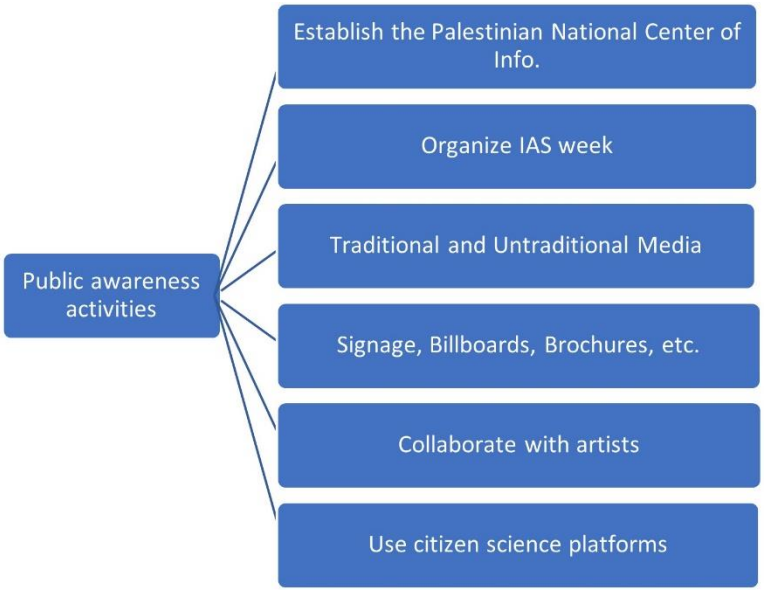


Figure 13: Various means of public awareness activities

3) Recommended Education Activities:

1. Include learning material about IAS and its impact in science school curriculum at all stages.
2. Organize educational programs to school and university students as part of the extra-curriculum activities. The Palestinian national center for information on IAS discussed above can provide educators with age-appropriate educational materials, interactive games, suggestions for activities, and field trips to utilize in these events.
3. Organize educational activities with environmental clubs within schools and universities. Encourage club members to spread the information they gained to their colleagues through creating artistic signs, plays, and in daily morning rituals.
4. Science teachers are encouraged to ask students to write essays about the most problematic IAS in Palestine.
5. Organize once a year an academic conference on IAS, with the involvement of various stakeholders to educate them about new research concerning IAS in Palestine.
6. Include a compulsory course in universities about IAS for students in environment related sectors.
7. University professors should encourage Master and PhD students to investigate IAS in their research projects.
8. Encourage regional research concerning IAS, and exchange of expertise.
9. Direct environmental NGO's and grassroot groups work towards educating about IAS.

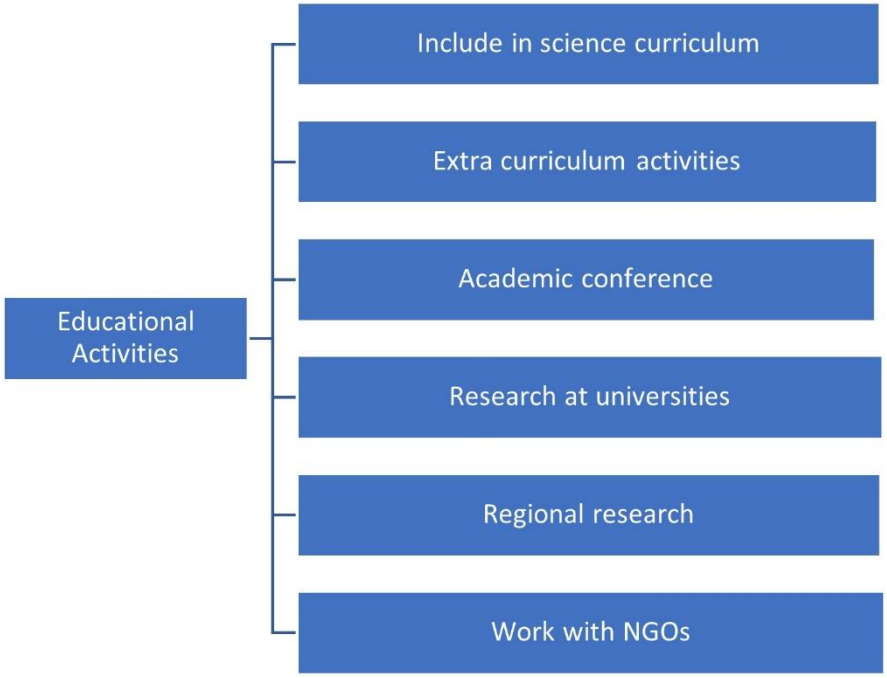


Figure 14: Various means of educational activities

Palestinian IAS Action Plan

The following action plan on Invasive Alien Species was prepared based on the Palestinian National Strategy for Mitigating and Managing the Threats of Invasive Alien Species (IAS)

Thematic Area A: Basics									
A1: Generating support									
Objective 1 -To survey and identify the most common IAS and their adverse negative effects on Biodiversity, Human health, and Environment, and to create various supporting systems to manage and decrease their impacts									
Actions	**Activities**	**Measurable Outcomes**	**Monitoring frequency**	**Target group**	**Target timeline**			**Lead Organizations**	**Participating Organizations**
					Short-Term (2022-2023)	**Medium-Term (2024-2025)**	**Long-Term (2025-2030)**		
Action 1.1.1: Increase the public awareness and outreach on IAS through establishing information center, media, science citizen	Establishing the Palestinian information center for IAS	The Palestinian information center on IAS	annually	School students, university students and the Public	X			EQA, MoA	Ministry of Education
	Promote IAS awareness through organizing the IAS week	activities and materials are available each year	annually	Students, farmers, stakeholders, policy makers	X			EQA, MoA	Ministry of Education
	Short documentaries in two national TVs	Documentaries	fortnightly	Public	X			EQA, MoA	Ministry of Information
	Short awareness messages in 5 national radio stations	short informative recordings	weekly	Public	X			EQA, MoA	Ministry of Information
	Monthly sponsored awareness messages (short videos/ posters) in 2 social media platforms	short videos/ posters	monthly	Public	X			EQA, MoA	Ministry of Information
	Promote awareness of IAS via 50 informative billboards	50 billboards are present	monthly	Public		X		EQA, MoA	Ministry of Local Governance
	Provide information about IAS via 50 signage in the nature reserves and trails	50 signs are installed	annually	Hikers, eco-tourists and nature enthusiasts	X			EQA, MoA	Ministry of Local Governance
	Promote IAS awareness through collaborating with artists	IAS relevant artistic contest	annually	Students at various stages			X	EQA, MoA	Ministry of Culture
	Provide citizen science virtual platforms	website and application	monthly	Public	X			EQA, MoA	Ministry of Local Governance
Action 1.1.2: Promote education concerning IAS and its adverse negative effects	Include education about IAS in science school curricula	IAS topic to be taught during the educational year	annually	School students		X		EQA, MoA	Ministry of Education

	Include education about IAS for university students in the environmental related studies	IAS course taught in universities	annually	University students		X		EQA, MoA	Ministry of Higher Education
	Extra curriculum activities within environmental clubs in schools and universities to raise awareness about IAS and their adverse negative effects	50 educational events are implemented annually within environmental clubs	annually	Students at various stages		X		EQA, MoA	Ministry of Education, Ministry of higher Education
	Integrate education about IAS into already existing programs offered by the EQA and MoA offered to farmers, beekeepers, shepherds		annually	Farmers, beekeepers, shepherds		X		EQA, MoA	
	Organize the IAS academic conference	The IAS annual conference is organized and a long-term plan is set for its sustainability	annually	Researchers, stakeholders, farmers, Master and PhD students		X		EQA, MoA	Ministry of Higher Education
	Conduct research relevant to IAS and its adverse negative effects on the environment, biodiversity, socio-economy & public health	universities and research centers are conducting research related to IAS in Palestine	annually	Researchers, Undergraduate, Master and PhD students	X			EQA, MoA	Ministry of Higher Education, research institutes & NGOs
	Promote regional research related to IAS and their adverse effects.	a regional network of IAS in the Eastern Mediterranean is established and regional research priorities are set	annually	stakeholders, researchers, Master and Ph.D. students		X		EQA, MoA	Ministry of Higher Education
	Promote work with NGOs	Environmental NGOs made aware of IAS and their negative impacts, and design IAS projects in accordance with the Palestinian national IAS strategic plan	annually	Environmental NGOs managers	X			EQA, MoA	

	Offer scholarships for graduate students to specialize in taxonomic identifications.	4 scholarships are offered	annually	Researchers		X		EQA, MOA	
Action 1.1.3: Promote public awareness concerning releasing/ escaping exotic pets into the wild	Educate the public about the possible consequences of releasing/ escaping exotic pets into the wild	radio and tv programs, short documentaries are produced	annually	public, pet shops, zoos		X		EQA, MOA	Ministry of Local Governance, Ministry of Education, & Ministry of higher Education
	Provide information via signed to hikers especially in environmentally sensitive areas urging them to stay on trails, never unfree pets, and remove plant material from shoes before leaving the area	60 signs are in place	N/A	Hikers, environmental enthusiastic		X		EQA, MOA	Ministry of local Governance
Action 1.1.4: Prioritize IAS management in the Palestinian national strategies	The management and threat of IAS is integrated with the Palestinian National Report and included in its strategic planning and actions	Palestinian national report(6th) to the CBD	every national report	decision makers	X			EQA, MOA	
Action 1.1.5: Funding is available to implement proposed activities in the IAS national plan	EQA and MoA identify and develop a funding plan from governmental sources and donors to implement IAS related activities	Funds are available from government and donors	annually	Government & International donors	X			EQA, MOA	International donors
A2: Capacity Building									
Objective 1.2 To build the national capacity of individuals, organizations, and communities towards identification, control, and management of IAS									
Action 1.2.1: Capacity building concerning IAS identification,	Create the national taxonomist registry by competent authorities	National registry of taxonomists	annually	Taxonomists	X			EQA, MOA	Ministry of Higher Education

control, and management at the individual level	Core capacity trainings concerning IAS for taxonomists and experts	Training materials and guidelines are developed	annually	taxonomists and environmental experts		X		EQA, MOA	
	Organize risk assessment trainings and management	Training materials and guidelines are developed	annually	taxonomists and environmental experts		X		EQA, MOA	
	Invest in the national pool of IAS related experts in national institutional capacity building	Training materials are developed	annually	taxonomists and environmental experts		X		EQA, MOA	
Action 1.2.2: Capacity building targeting organizations at the national level	Capacity building among national IAS competent authority staff and other stakeholders for a reliable taxonomic identification	training programs/ materials, and guidelines are developed	annually	national competent authorities	X			EQA, MOA	
	Create the national list of IAS and their distribution	National list of IAS	biannually	competent authorities, researchers, taxonomists	X			EQA, MOA	
	Create and update periodically the national list of IAS of highest concern	national list of highest concern IAS	annually	competent authorities, researchers, taxonomists	X			EQA, MOA	
	Publish guides and manuals for identifying IAS	IAS identification guides	annually	competent authorities, researchers, taxonomists	X			EQA, MOA	
	Establish procedures on collecting and analyzing existing data on IAS.	IAS existing data of 30 species is standardized	annually	competent authorities		X		EQA, MOA	
	Improve the infrastructure (data collection, processing, and management) for IAS, and the establishment of a structural unit specialized in IAS control, and management.	IAS unit	N/A	competent authorities	X			EQA, MOA	
	Create inventories for IAS, and identify existing expertise and existing research for each species.	Inventories for each IAS are created	annually	competent authorities		X		EQA, MOA	

	Keep IAS inventories up-to-date, including its adverse effects on biodiversity, pictures, control procedures, and identification tools	Inventories for each IAS is updated	annually	competent authorities		X		EQA, MOA	
	Use Clearing House Mechanism platform to create an online “Central Information System on IAS” to include IAS inventories	Central Information System on IAS	biannually	competent authorities, stakeholders, researchers		X		EQA, MOA	
	Organize training workshops for border inspectors and custom officers	Training materials and guidelines are developed	annually	border inspectors and custom officers	X			EQA, MOA	Ministry of Interior
	Increase risk assessment capacities for IAS	Training materials and guidelines are developed	annually	competent authorities, stakeholders, researchers		X		EQA, MOA	
	Increase capacity concerning IAS legislations and operational capacities to implement the policies.	Training materials are developed	annually	competent authorities, stakeholders		X		EQA, MOA	Ministry of Justice
	Invest in “centers of excellence” to do research on the biology of invasion, threat, risk analysis, and innovative solutions	three centers of excellence are created	NA	competent authorities, stakeholders, researchers			X	EQA, MOA	Ministry of higher education
	Strengthen the technical capacity of the “Plant and Animal Quarantine and Phytosanitary Department”	Training materials are developed	annually	Plant and Animal Quarantine and Phytosanitary Department	X			EQA, MOA	
	Create the national database with all invasive species projects	National database is created	annually	competent authorities, stakeholders, researchers		X		EQA, MOA	Ministry of Higher Education, research institutes and NGOs
	Promote cross-sectoral cooperation and exchange of expertise by involving scientists, environmental managers, citizens in invasive species targeted programs	20 meeting are organized	annually	scientists, environmental managers, citizens		X		EQA, MOA	

Action 1.2.2: Capacity building targeting organizations at the regional / / global levels	Join global and regional invasive species networks	three regional/ global networks are joined	N/A	competent authorities		X		EQA, MOA	
	Initiate the creation of a regional initiative in the East-Mediterranean region for invasive species management	East-Med IAS regional network is created	N/A	competent authorities			X	EQA, MOA	
	Benefit from regional initiatives in creating collaborative action plans to limit the entry of new IAS, and cooperate on optimal management strategies.	10 collaborative plans are created	N/A	competent authorities			X	EQA	
	Engage with global mechanisms to achieve coordination between regional networks and agencies	Engagement with 5 global mechanisms	N/A	competent authorities			**X**	EQA	
	To identify relevant regional/ international expertise and networks and integrate them with national inventories		annual	competent authorities		**X**		EQA	
Action 1.2.3: Capacity building targeting communities	Create an interactive mobile application to identify and report IAS	mobile application is developed	N/A	public		X		EQA, MOA	
	Provide information about IAS and its adverse effects on biodiversity	25 leaflets are created, website	biannually	public		X		EQA, MOA	
	Create “community IAS groups” and provide them with skills, information, and resources.	50 community groups are created	annually	youth, women, scouts, environmental clubs, farmers, & eco-touristic agencies			X	EQA, MOA	Ministry of Tourism, Ministry of Education
	Organize workshops and trainings for "community IAS groups" As well as a focal point to link the committees to relevant decision makers.	50 workshops are executed 50 focal points are assigned and active	annually	youth, women, scouts, environmental clubs, farmers, & eco-touristic agencies			X	EQA, MOA	Ministry of Tourism, Ministry of Education

	Incorporate “citizen science” concept in the management plans of IAS, and provide skills to community members.	1000 person use citizen science platform	annually	citizens			X	EQA, MOA	
A3: Legislations and Policies									
Objective -1.3 To develop and establish a proper and active legislations and policies in order to support the effective management and control of IAS									
Action 1.3.1: Regulations and policies related to IAS are passed complementing the Environment law in order to prevent IAS entry, and to improve IAS's control and management	Development of IAS bylaw to complement the Palestinian environment law and accepted by the Government,	IAS bylaw is passed	annually	competent authorities	X			EQA, MOA	Ministry of Justice, Prime Minister's office
	Development of operational manuals, policies, and procedures translating the developed IAS bylaw	Manuals, policies, and procedures are developed	annually	competent authorities		X		EQA, MOA	Ministry of Justice
	Capacity building among competent authorities concerning the IAS bylaw is executed	Training materials and guidelines are developed	annually	competent authorities		X		EQA, MOA	
	Palestine joins International IAS related Agreements	CITES, Bonn convention are joined	N/A	competent authorities		X		EQA, MOA	

Thematic Area B: Baseline and Monitoring									
B1: Tools towards Decision Making									
Objective- 2.1 To adopt and establish/execute methodologies and set-ups for baseline surveys evaluating the status, distribution, and impacts of IAS									
Actions	**Activities**	**Measurable Outcomes**	**Monitoring frequency**	**Target group**	**Target timeline**			**Lead Organizations**	**Participating Organizations**
					Short-Term (2022-2023	**Medium-Term (2024-2025)**	**Long-Term (2025-2030)**		

Action 2.1.1 The status of IAS and their adverse impacts are determined through systematic surveys.	systematic annual surveys are established with special focus on nature reserves, and key biodiversity areas, disturbed habitats, and roadside	Survey outcomes are published on the CHM	biannual	competent authorities	X			EQA, MoA	Universities, research Institutes, NGOs
Action 2.1.2 Proper documentation to the status of IAS and their adverse impacts is established	The CHM platform is used to document IAS status and impacts	data is uploaded on the CHM platform	annual	competent authorities	X			EQA, MoA	
B2: Risk Assessment									
Objective -2.2 To develop and establish risk assessment protocols for enabling prioritization of IAS									
Action 2.2.1 Risk assessment protocols and procedures with respect to environment, biodiversity, health, socio-economic status) are developed	develop risk assessment procedures for both new IAS incursions as well as established species	Risk assessment procedures are developed	annual	competent authorities		X		EQA, MoA	Ministry of Health
Action 2.2.2 Capacity building concerning IAS risk assessment protocols and procedures	training sessions for competent authorities concerning IAS risk assessment	training material	annual	competent authorities		X		EQA, MoA	
Action 2.2.3 Prioritization IAS in accordance with the risk assessment procedures	Determine IAS ranking in the priority list	priority list	annual	competent authorities		X		EQA, MoA	
Action 2.2.4 Conduct research on prioritized IAS	Universities and research institutes conduct research about the ecology and biology of prioritized IAS as well as their management strategies.	research outcomes, publications	N/A	research institutes, excellence centers, universities, NGOs		X		EQA, MoA	Ministry of Higher Education

Thematic Area C: Management									
C1: Preventing IAS from spreading									
Objective - 3.1 To develop and establish an effective early detection mechanism to prevent new incursions, and methods to prevent spread of established IAS									
Actions	**Activities**	**Measurable Outcomes**	**Monitoring frequency**	**Target group**	**Target timeline**			**Lead Organizations**	**Participating Organizations**
					Short-Term (2022-2023	**Medium-Term (2024-2025)**	**Long-Term (2025-2030)**		

Action 3.1.1 Quarantine and border inspection procedures, protocols and mechanisms are established/improved to prevent new IAS entries to Palestine	Identify major pathways for IAS entries to Palestine, and share with quarantine and border inspectors	List of pathways is developed	Annual	Quarantine and border inspectors & custom officers		X		EQA, MoA	Ministry of Interior
	Create lists of high-risk IAS possible incursions	List of high-risk IAS is developed	Annual	Quarantine and border inspectors & custom officers		X		EQA, MoA	Ministry of Interior
	Increase IAS identification capacity	Training material	Annual	Quarantine and border inspectors & custom officers		X		EQA, MoA	Ministry of Interior
	Produce brochures and information sheets concerning high risk IAS and share with tourists	brochures/ information sheets are produced	Annual	Quarantine and border inspectors, tourists		X		EQA, MoA	
	Increase the capacity concerning IAS related legislations	Training material	Annual	Quarantine and border inspectors & custom officers		X		EQA, MoA	Ministry of Justice
Action 3.1.2 IAS treatment procedures are established	Treatment procedures for high-risk IAS are developed by experts and adopted by competent authorities	Treatment procedures and protocols are developed	Annual	Competent authorities	X			EQA, MoA	Universities, research centers and Institutes, NGOs
	Capacity building programs are implemented to increase knowledge about IAS treatment procedures and best practices	Training material	Annual	Contractors of treatment procedures, competent authorities		X		EQA, MoA	
Action 3.1.3 Mechanism for controlling the spread of established IAS in Palestine are active	Inspection for the nurseries (including plants, puts, soil, compost, dirt, machinery and equipment) to prevent new IAS from spreading	Inspection team is formed	Monthly	Nurseries	X			EQA, MoA	
	Propagation and growing of IAS by nurseries is stopped.	Inspection team is formed	N/A	Nurseries	X			EQA, MoA	
	Afforestation activities with IAS is stopped.	Surveys show no new IAS are planted	N/A	Competent authorities	X			EQA, MoA	Ministry of Local Governance
	Soil, gravel, and dirt movement is supervised and only permitted after inspection	Inspection procedures are developed	N/A	competent authorities		X		EQA, MoA	Custom Officers & tourist police

	Machinery, trucks, and vehicles movement is restricted from infested areas	Inspection procedures are developed	N/A	competent authorities		X		EQA, MoA	Custom Officers & tourist police
Action 3.1.4 An Early Detection and Rapid Response system is established and activated	The national "surveillance department" is created to follow up with new invasions, and periodically collect relevant data	National Surveillance department	N/A	competent authorities	X			EQA, MoA	
	An online user-friendly database for reporting purposes is created	online database is launched	N/A	public		X		EQA, MoA	
	A national alarm list, watch list, and black list for rapid detection is developed	lists are developed	annual	competent authorities, stakeholders, researchers		X		EQA, MoA	
	Regular surveillance for high-risk areas, ecological sensitive, and disturbed areas	surveillance reports	bi-annual	competent authorities, stakeholders, researchers	X			EQA, MoA	
	Coarse screening mechanisms are developed and updated	Coarse screening mechanisms	annual	competent authorities, stakeholders, researchers		X		EQA, MoA	
	Funding for rapid response is available	Funds	annual	competent authorities		X		EQA, MoA	International Doners
	Rapid response actions for species found on the alert list are prepared	rapid response actions	annual	competent authorities		X		EQA, MoA	
	Rapid response reports are prepared after each EDRR plan	Rapid response reports	N/A	competent authorities				EQA, MoA	
C2: Management of established IAS									
Objective - 3.2 To Eradicate and control of Established IAS species when applicable									
Action 3.2.1 Best practices for management of established IAS are implemented	Capacity building trainings on eradication, control, and containment techniques are executed	Training material	annual	Competent authorities, stakeholders, researchers		X		EQA, MoA	
	General plan for eradication, containment, and control of groups of species similar in characteristics are prepared	Eradication, containment and control plans	annual	competent authorities		X		EQA, MoA	Universities, research centers and Institutes, NGOs
	Pilot eradication and control for high-risk IAS in priority sites took place	pilot sites/ progress reports	N/A	competent authorities	X			EQA, MoA	

Action 3.2.2 High risk IAS are eradicated when possible	Review eradication methods and customize best practice that are suitable in Palestine. Execute best eradication methods.	Final reports are produced	N/A	competent authorities, stakeholders, researchers			X	EQA, MoA	Universities, research centers and Institutes, NGOs
Action 3.2.3 Identify and develop biocontrol agents to control high risk IAS when possible	review and identify potential biocontrol agents and decide on priority sites to be controlled	potential biocontrol agents are identified	N/A	competent authorities, stakeholders, researchers		X		EQA, MoA	Universities, research centers and Institutes, NGOs
Action 3.2.4 High risk IAS are controlled when eradication is not possible	Feasibility studies are performed to decide on best control methods for high-risk IAS. Plans are formulated and enforced of the best control method.	Control plans are developed	N/A	competent authorities, stakeholders, researchers		X		EQA, MoA	Universities, research centers and Institutes, NGOs
C3: Site Restorations									
Objective - 3.3 To Recover and restore the native biodiversity after implementation of eradication and control procedures									
Action 3.3.1 Restoration of the targeted sites, after management plans are executed.	Evaluation of best restoration actions needed and executed accordingly	Sites are restored	N/A	competent authorities, stakeholders, researchers			X	EQA, MoA	Ministry of local governance

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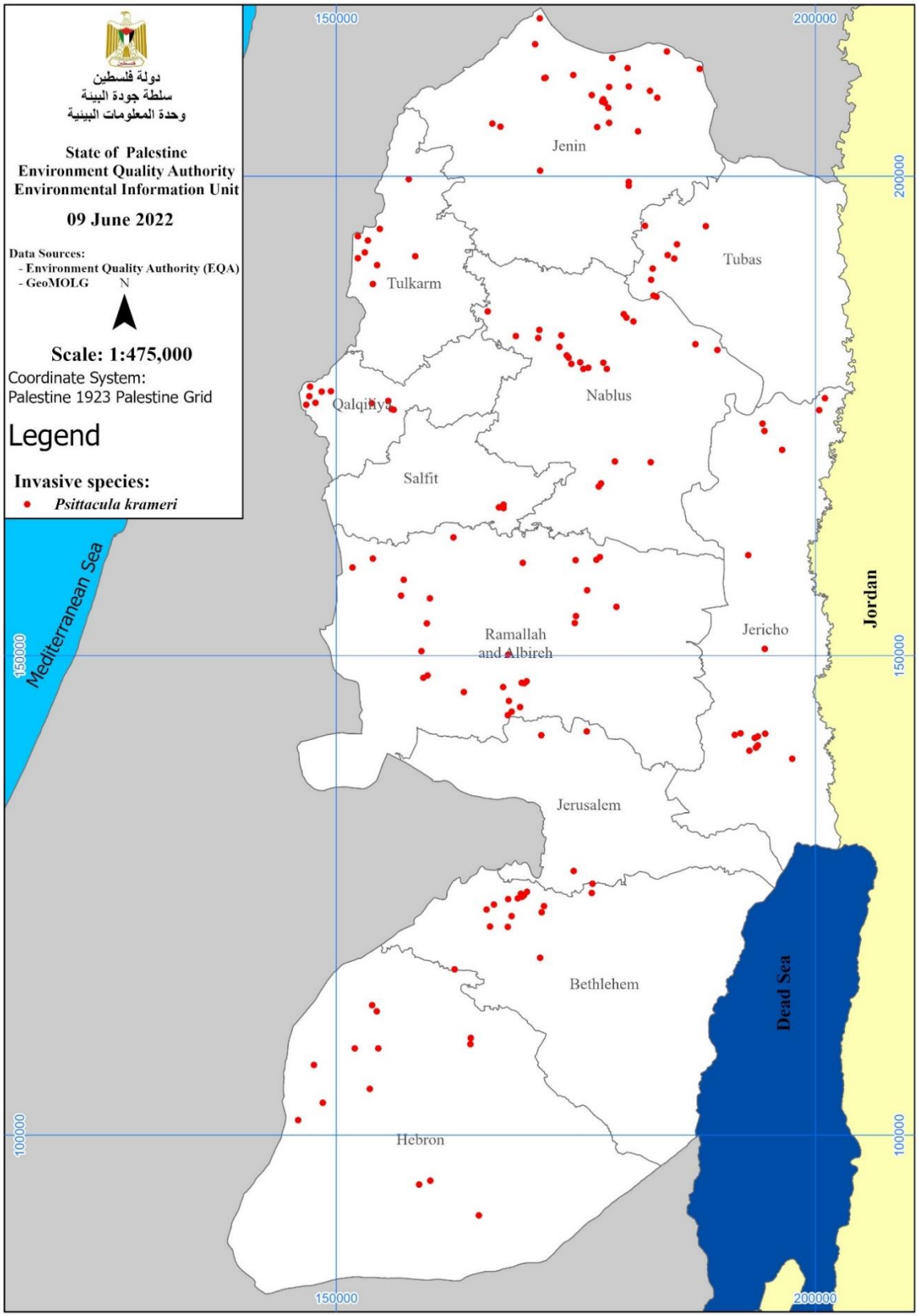
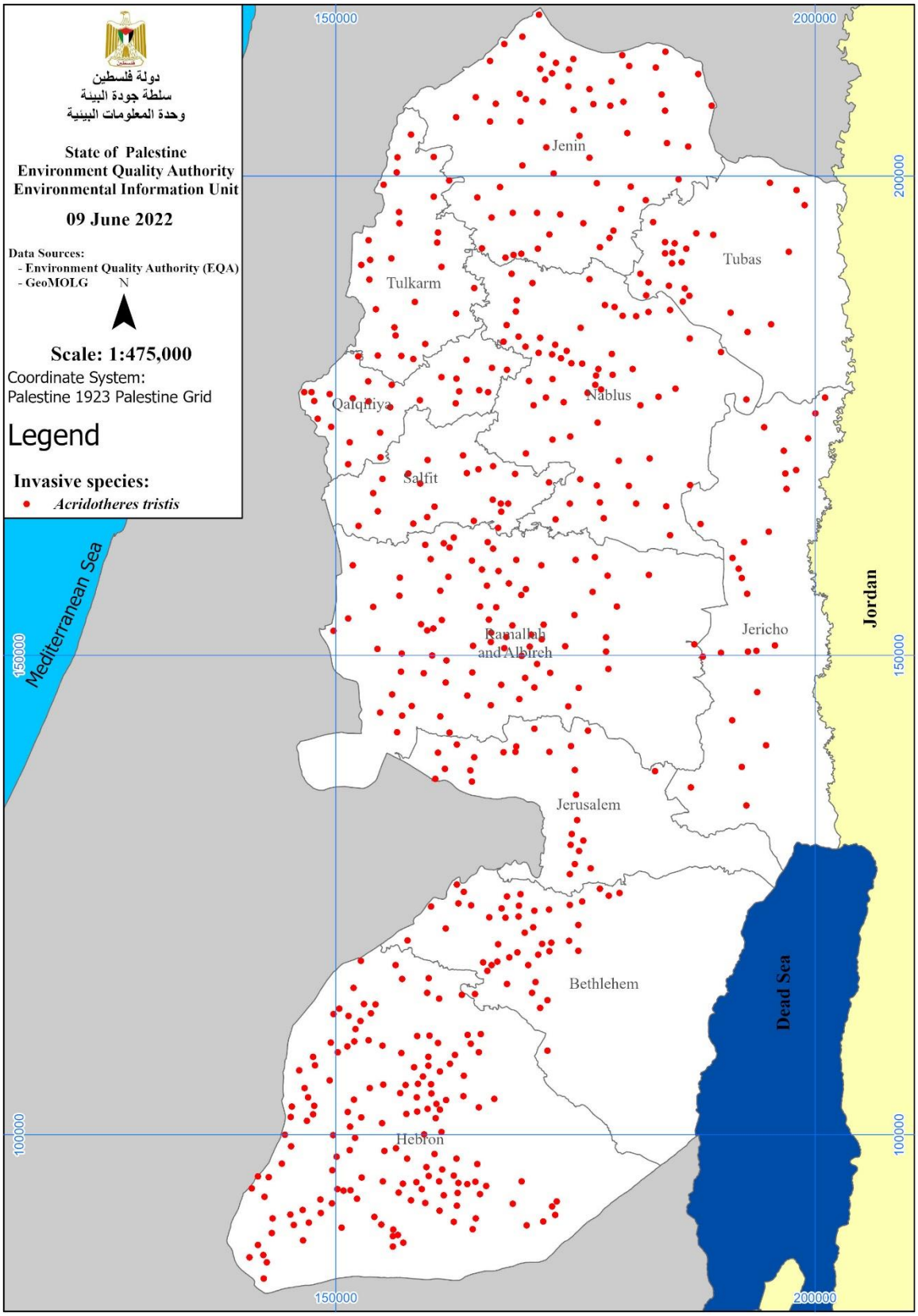
Appendices:

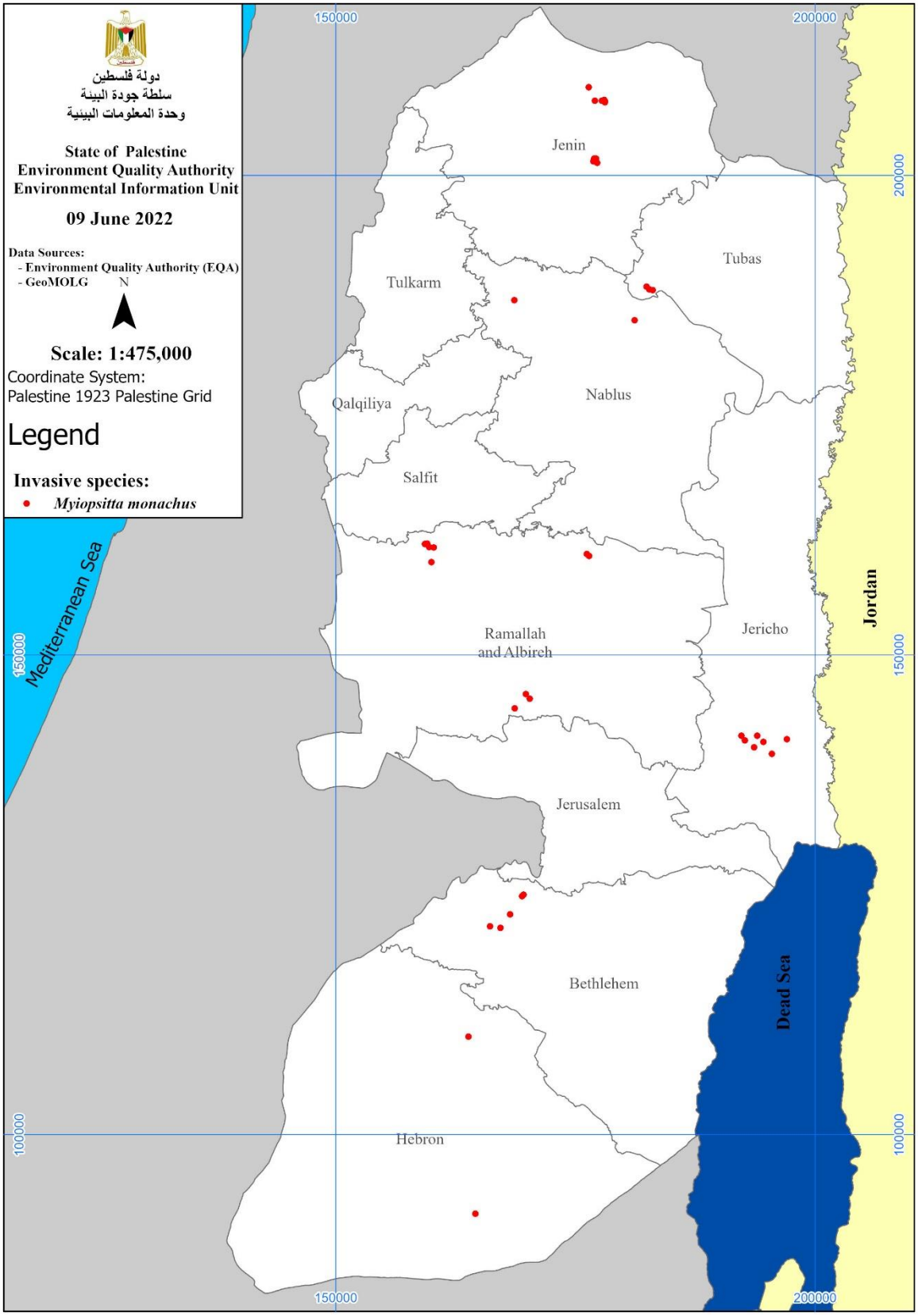
Appendix A) The distribution maps of the Recorded IAS



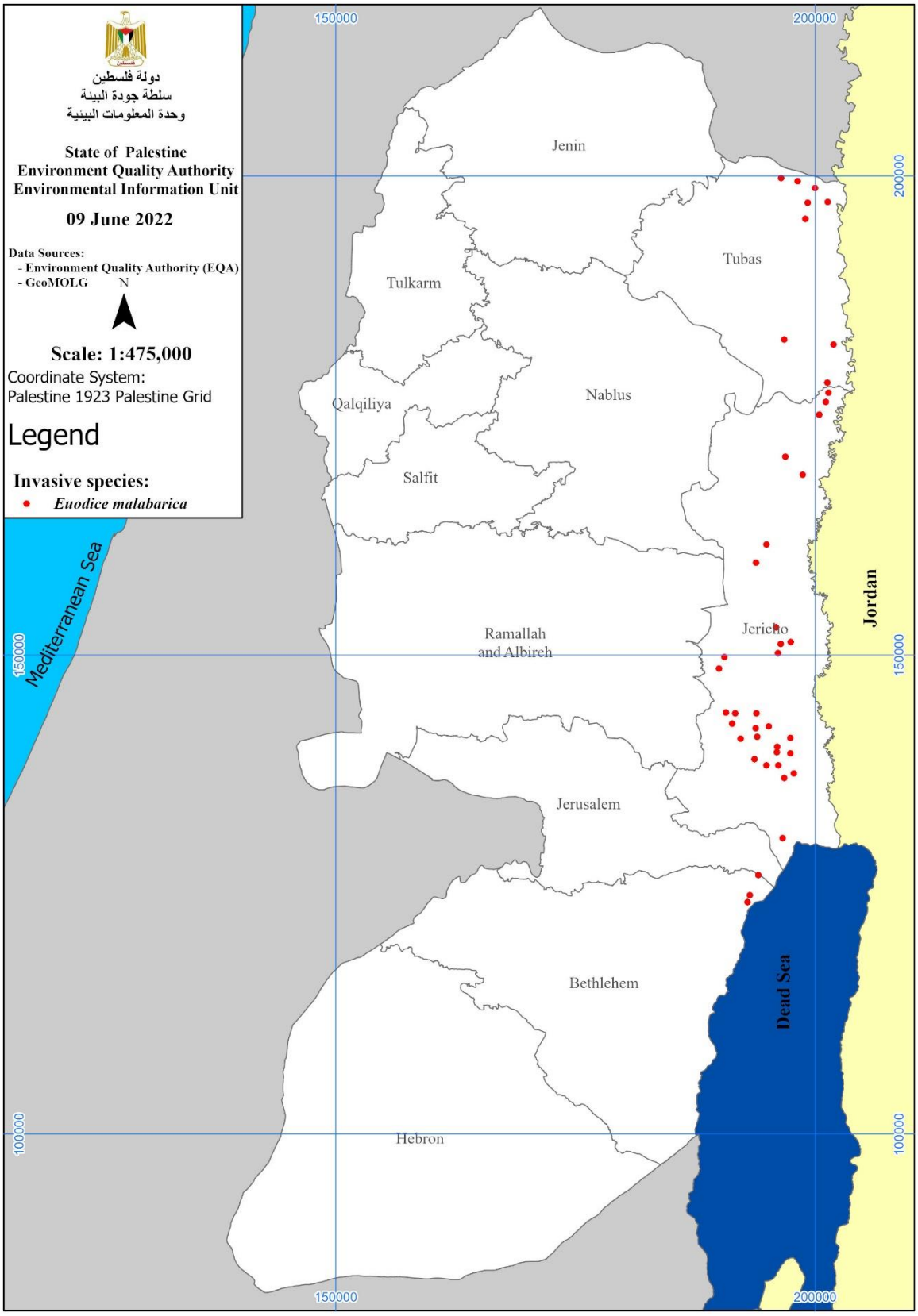
Map 1) The distribution of the *Psittacula krameri* (Rose-ringed parakeet)



Map 2) the distribution of the Acridotheres tristis (Common myna)



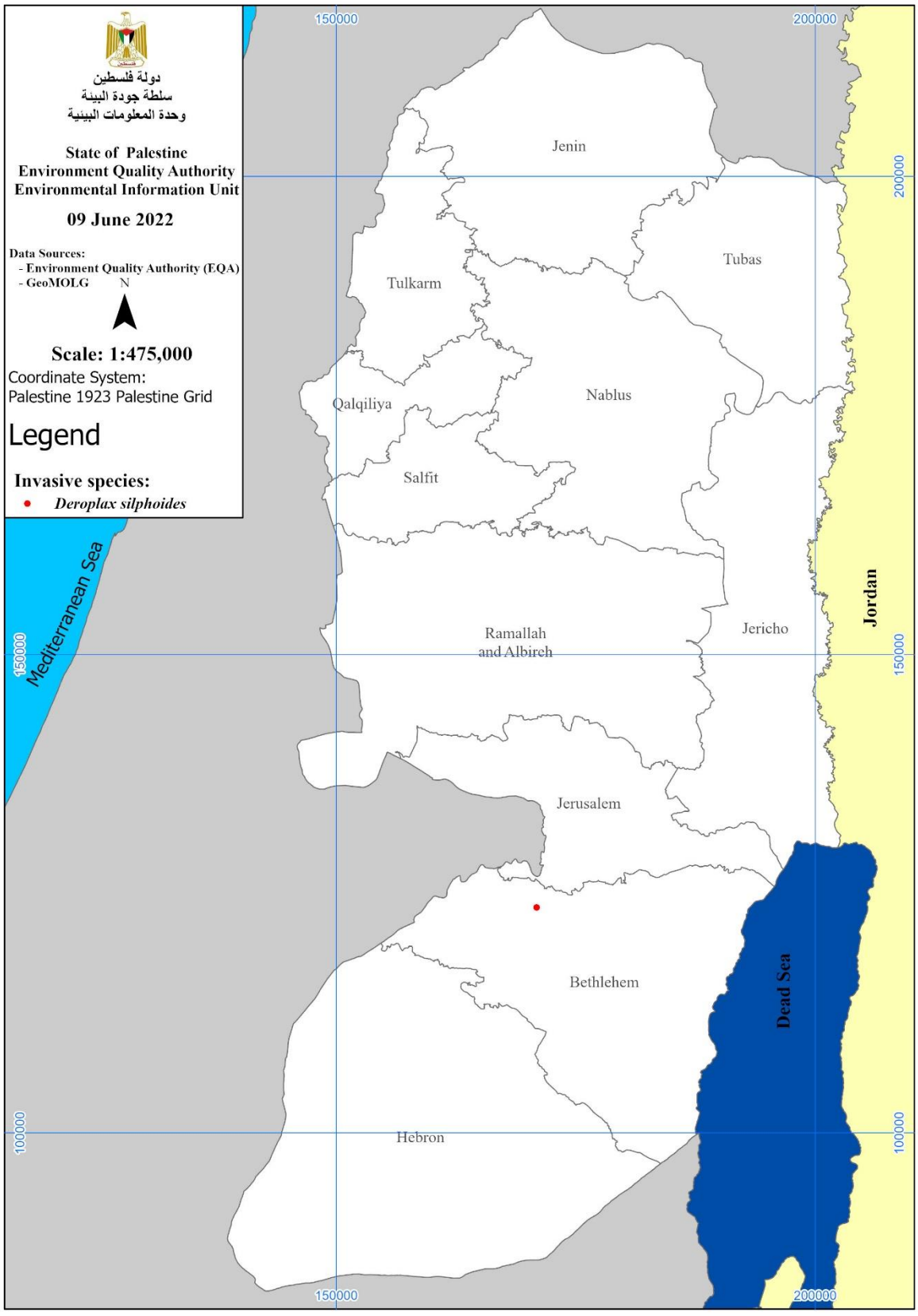
Map 3) the distribution of the *Myiopsitta monachus* (Monk parakeet)



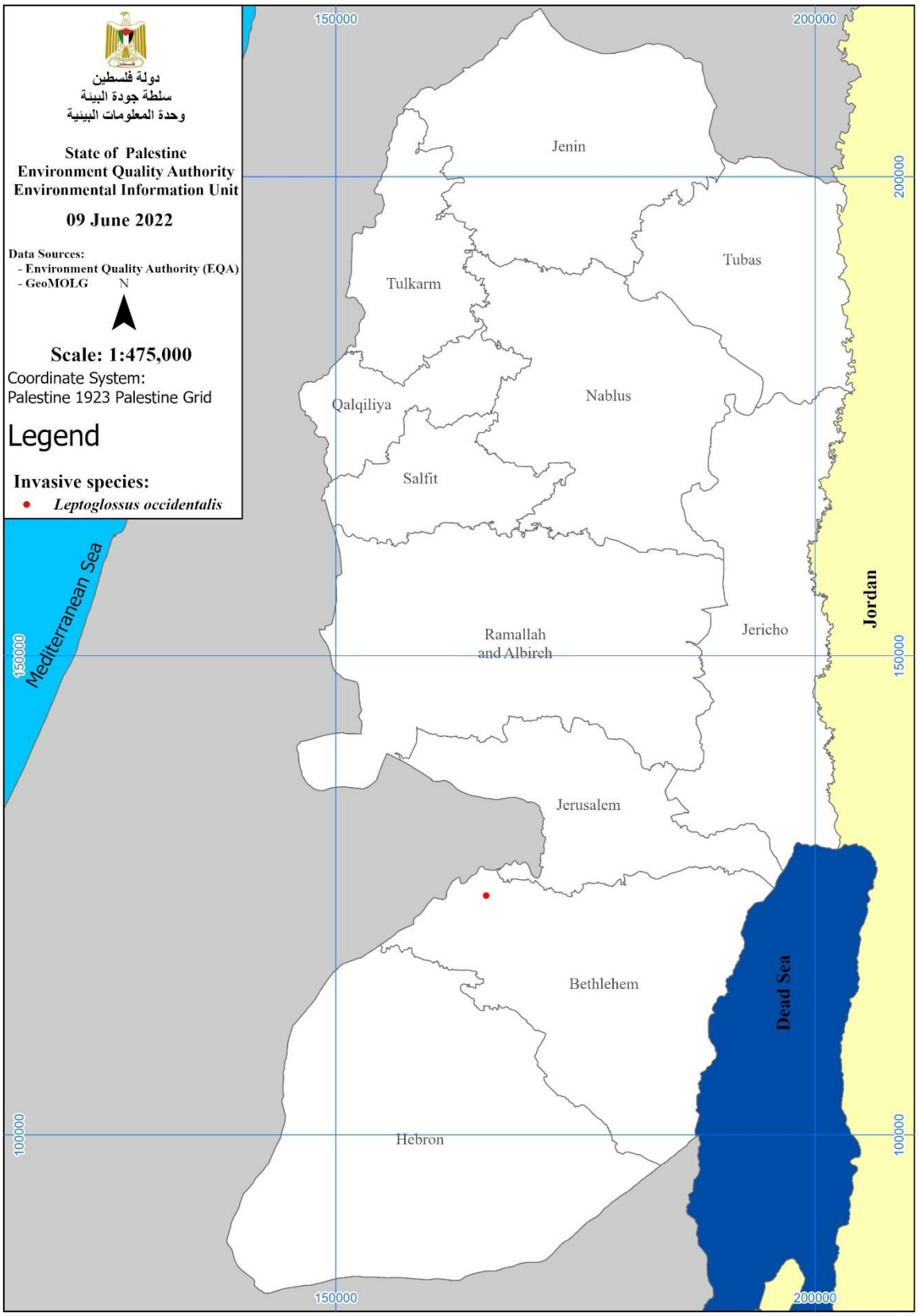
Map 4) the distribution of the *Euodice malabarica* (Indian silverbill)

Map 5) The distribution of the *Myocastor coypu* (Coypu, Nutria)

Map 6) The distribution of the *Trachemys scripta elegans* (Red-Eared Slider)

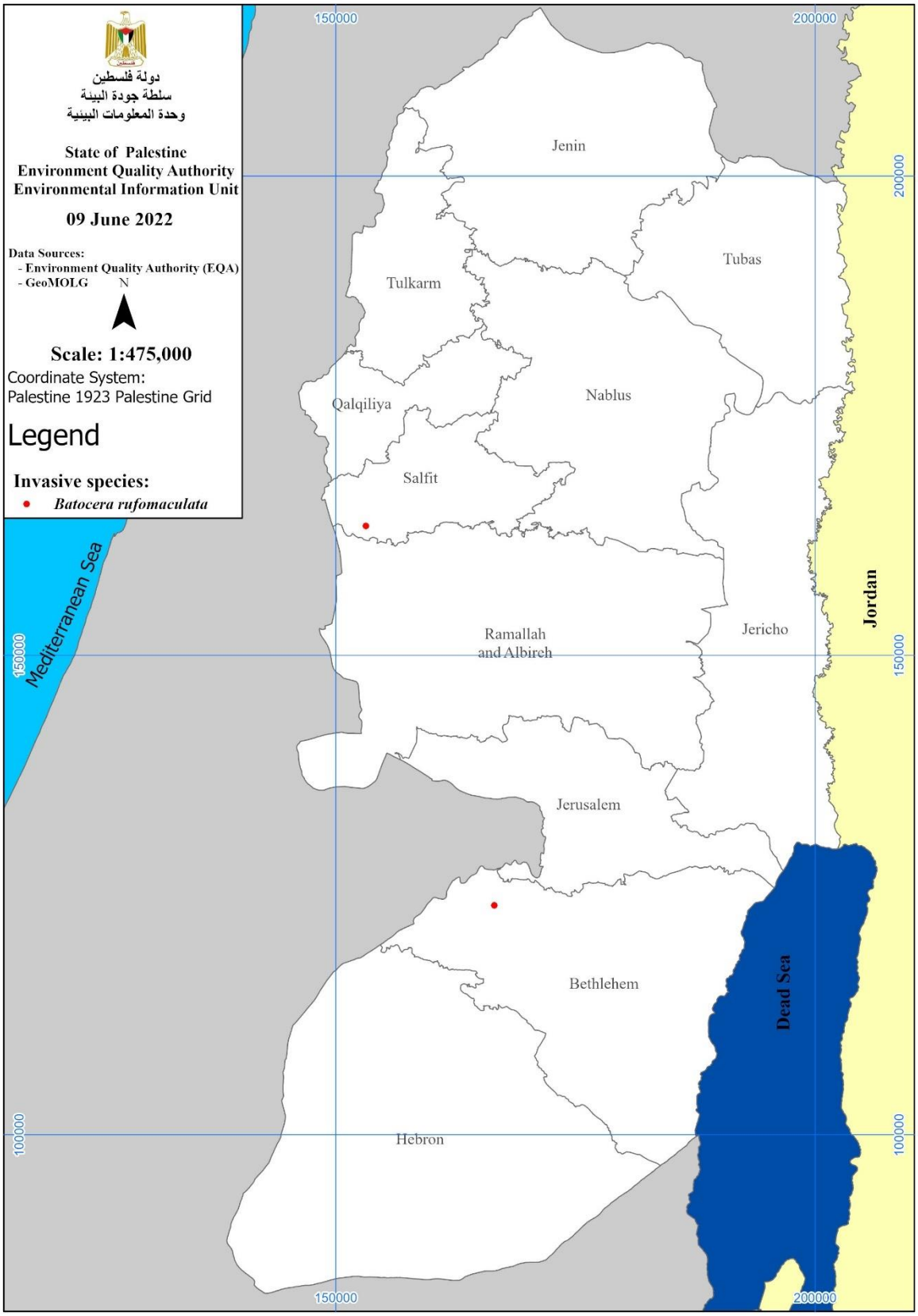


Map7) The distribution of the *Deroplax silphoides* (scutellerid shield bug)

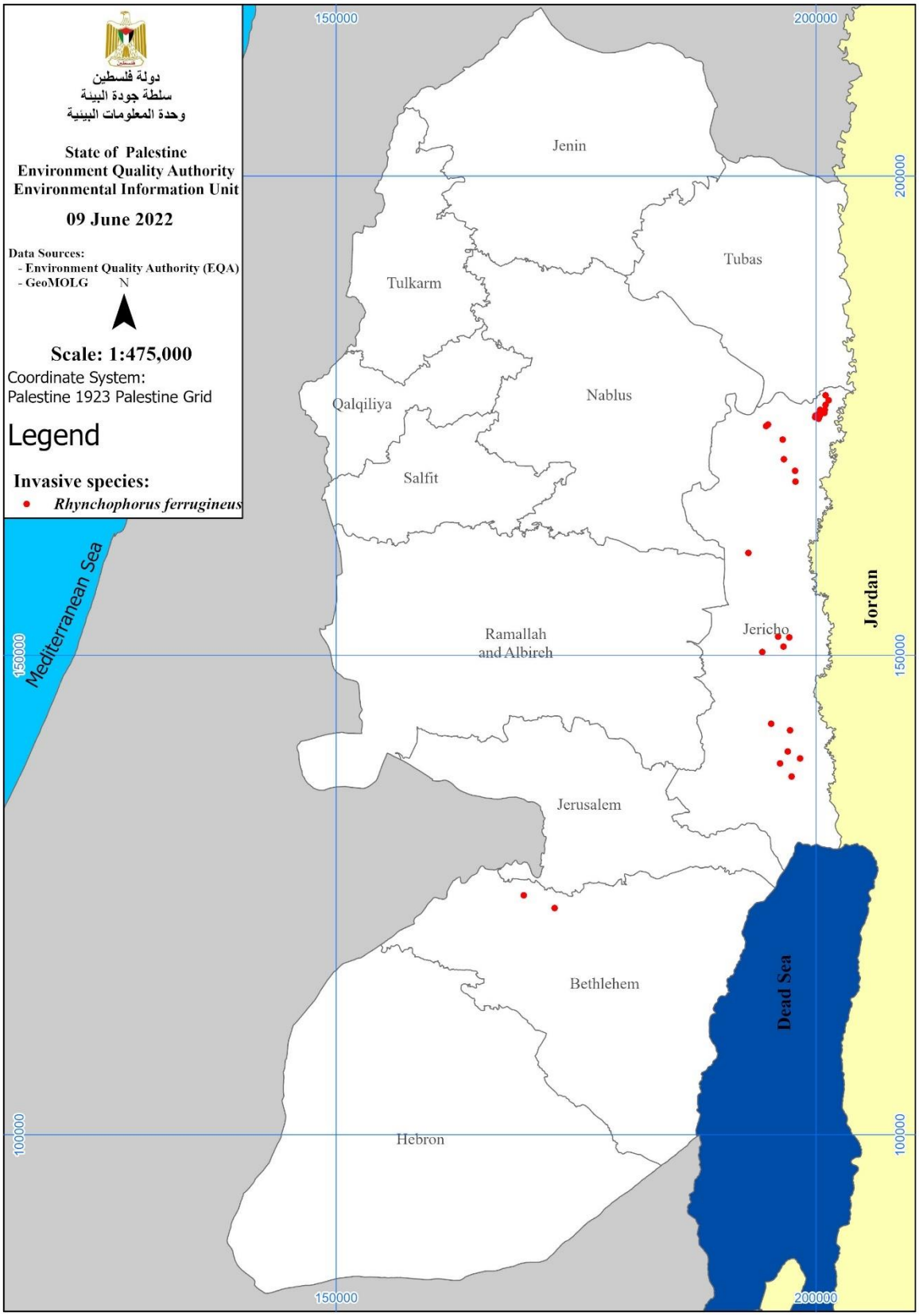


Map 8) The distribution of the Leptoglossus occidentalis

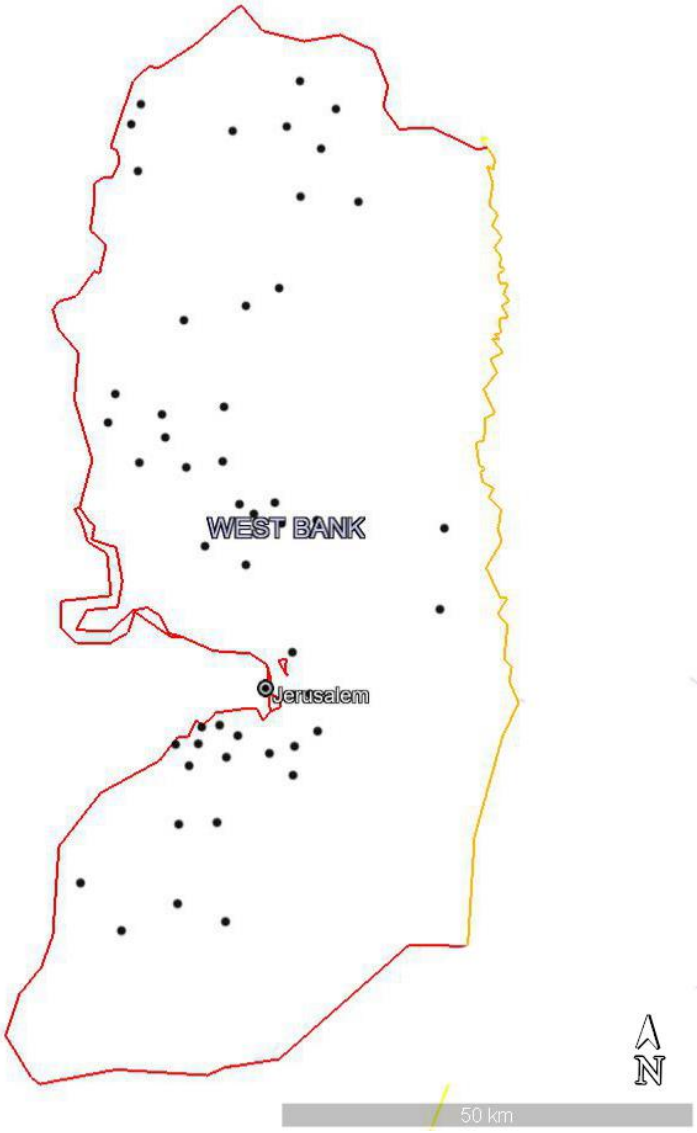
Map 9) The distribution of the *Periplaneta americana* (American cockroach)



Map 10) The distribution of the Batocera rufomaculata

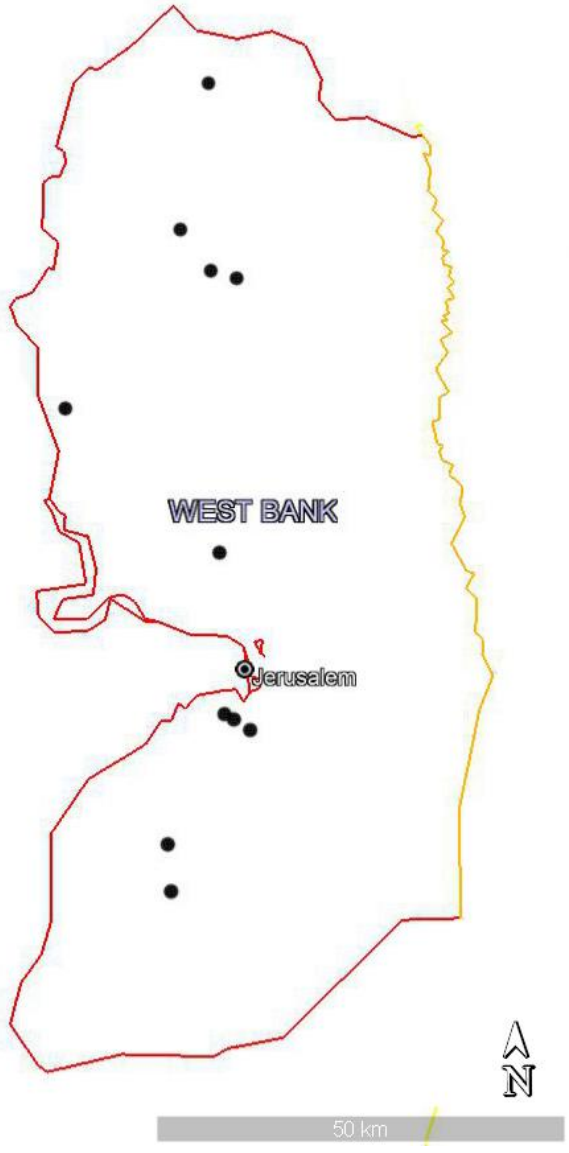


Map 11) The distribution of the Rhynchophorus ferrugineus

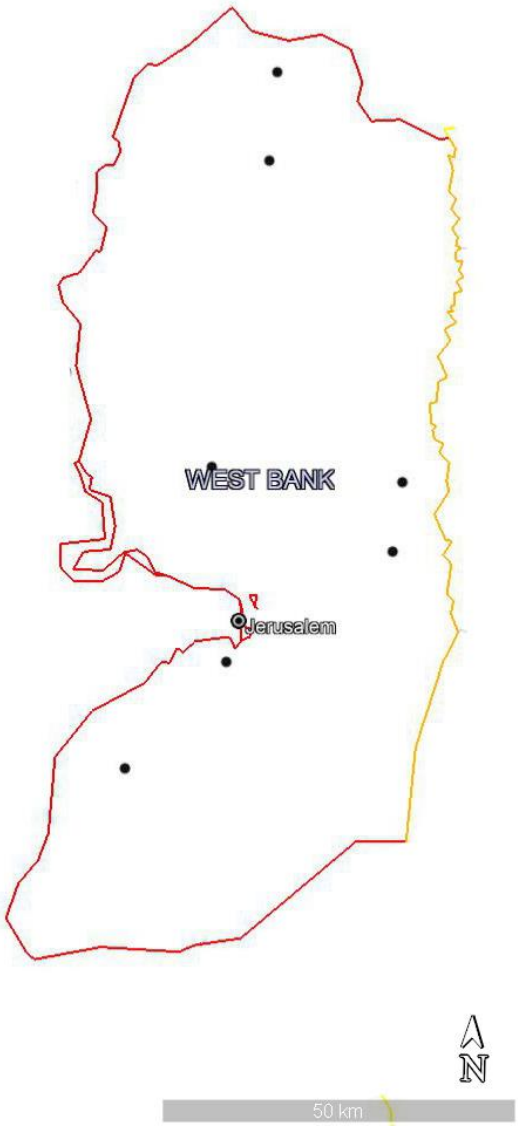


Map 12) The distribution of the *Ceratitis capitata* (Mediterranean fruit fly)

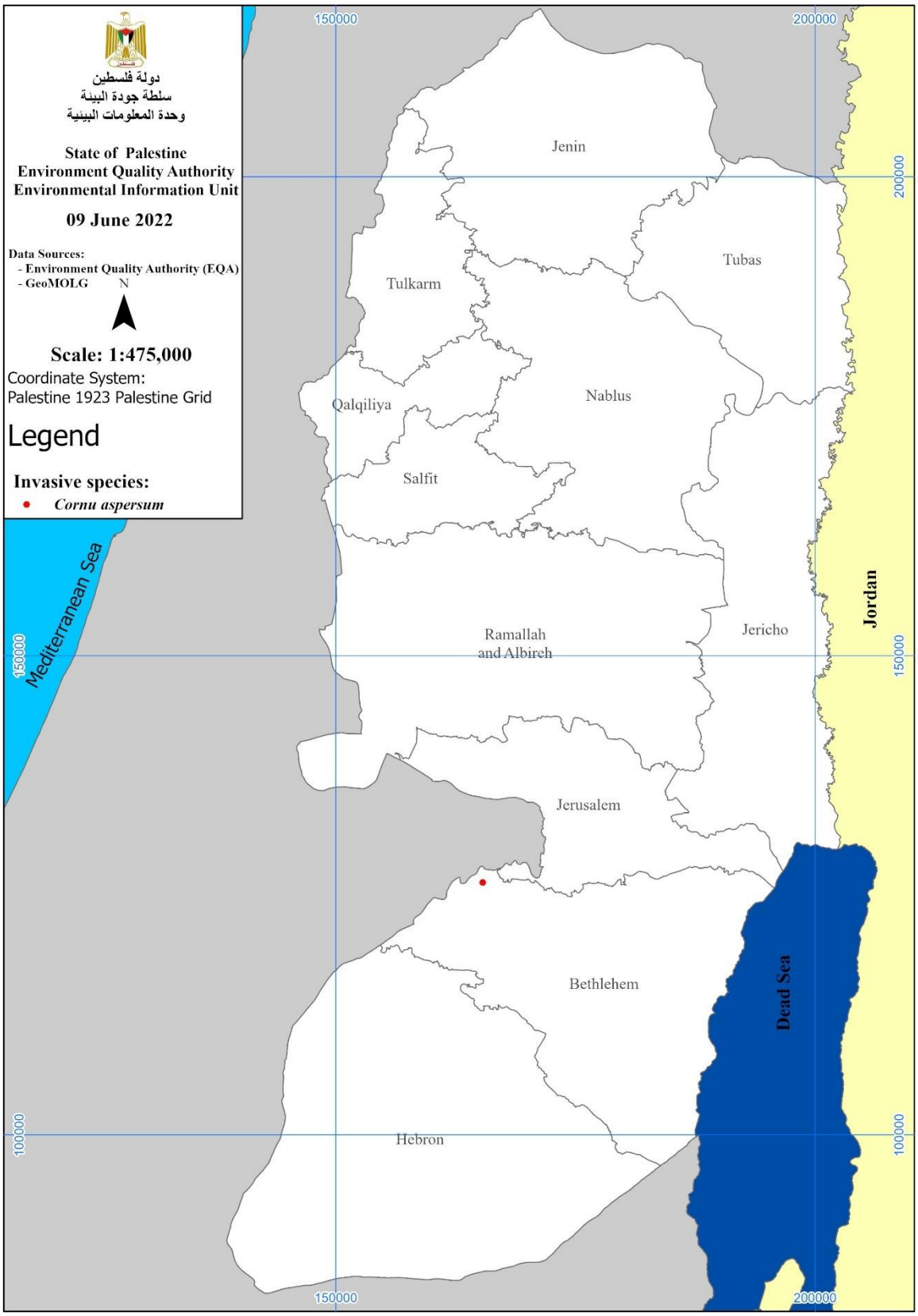
Map 13) The distribution of the *Myopardalis pardalina* (Baluchistan Melon Fly)



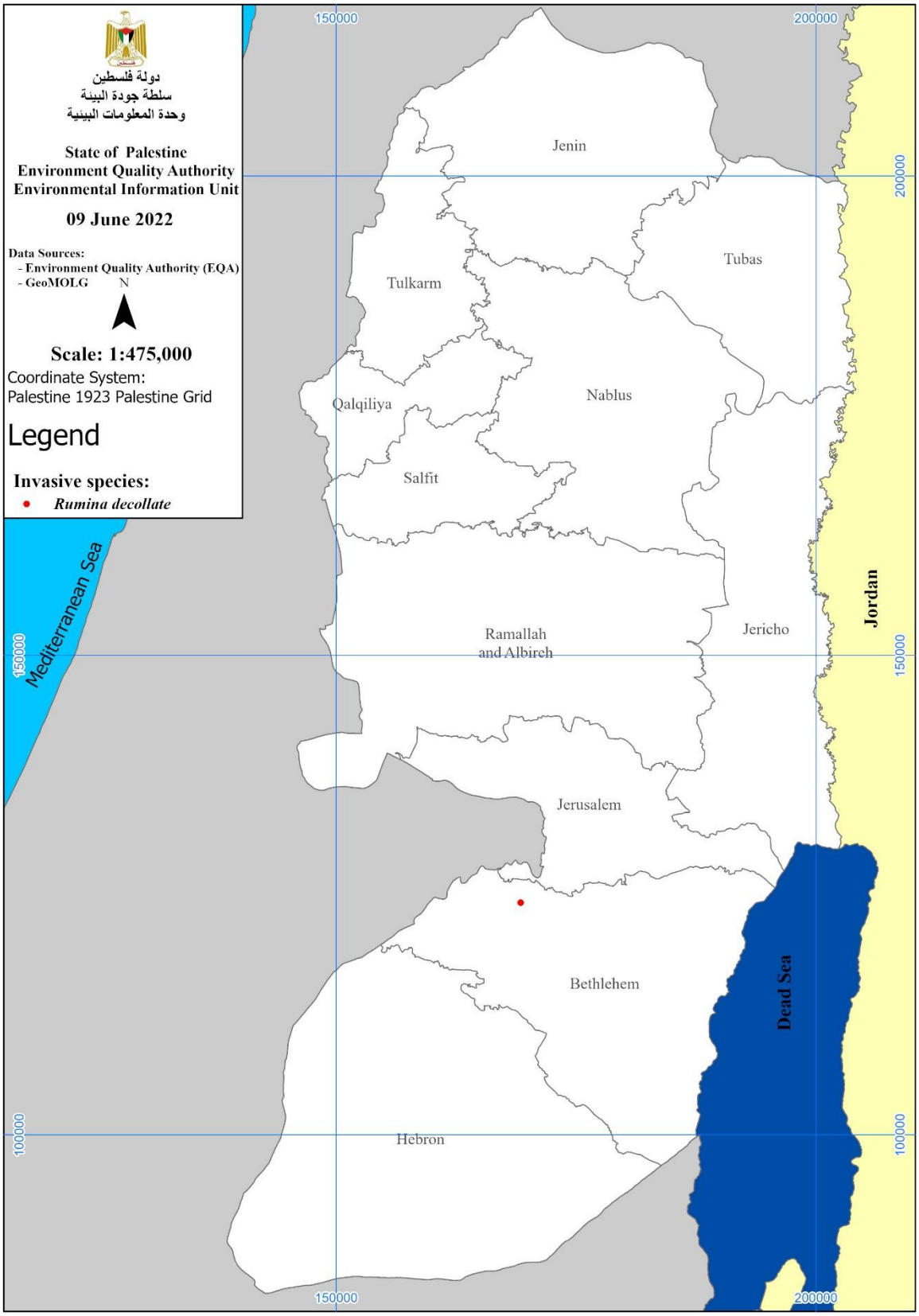
Map 14) The distribution of the *Aedes albopictus* (Asian tiger mosquito) to be added



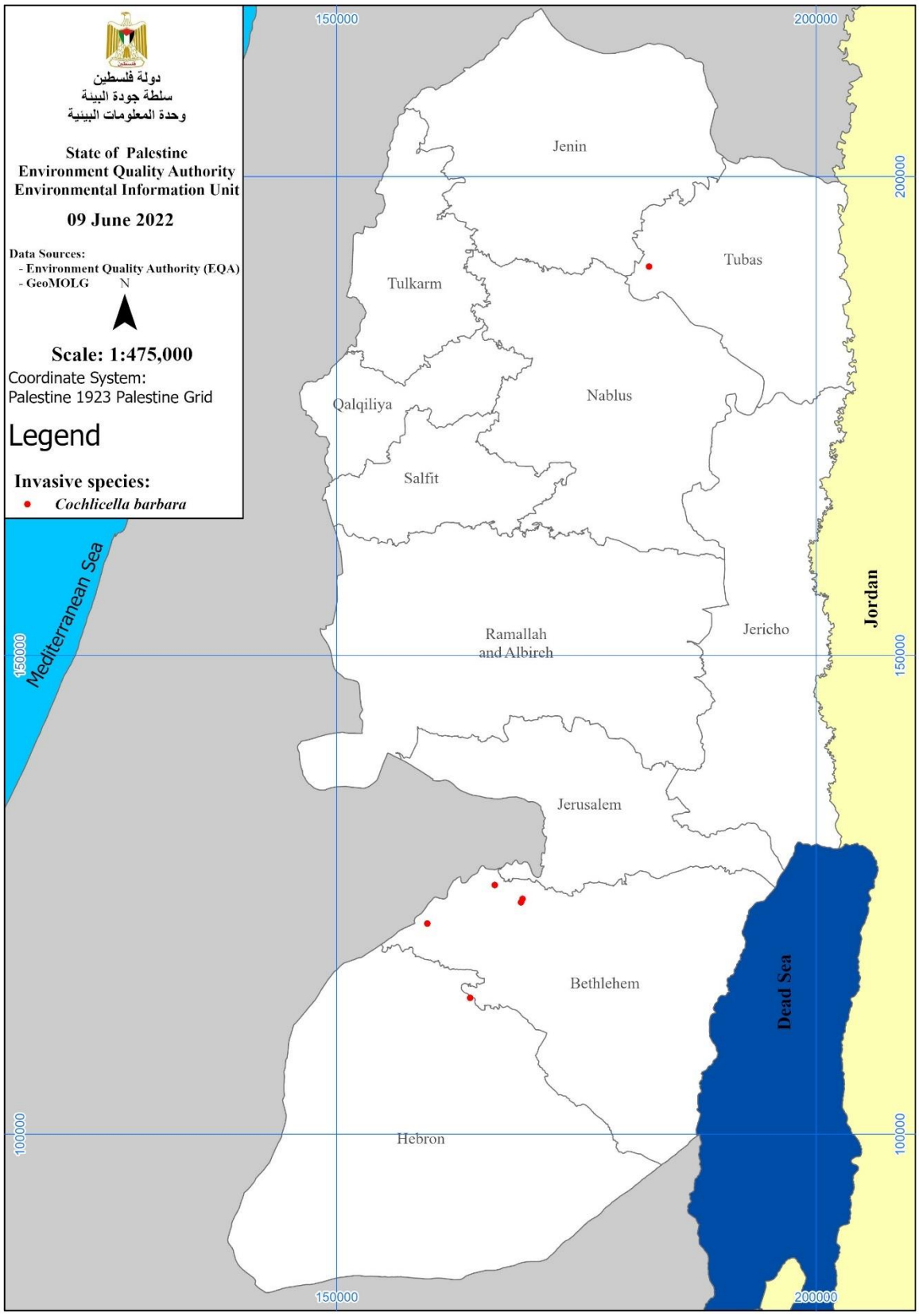
Map 15) The distribution of the *Tuta absoluta* (The South American tomato moth)



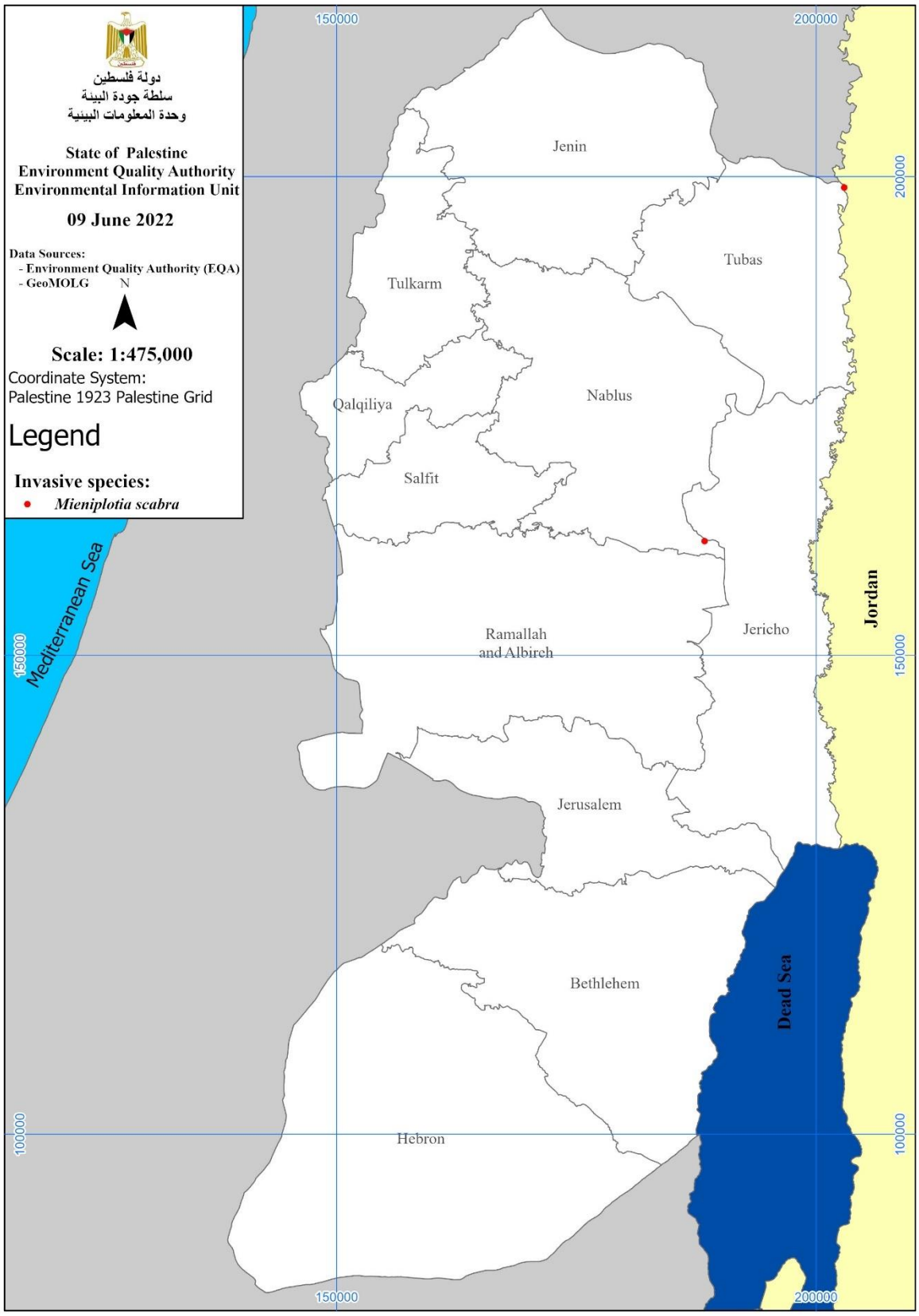
Map 16) The distribution of the *Cornu aspersum* (Garden Snail)



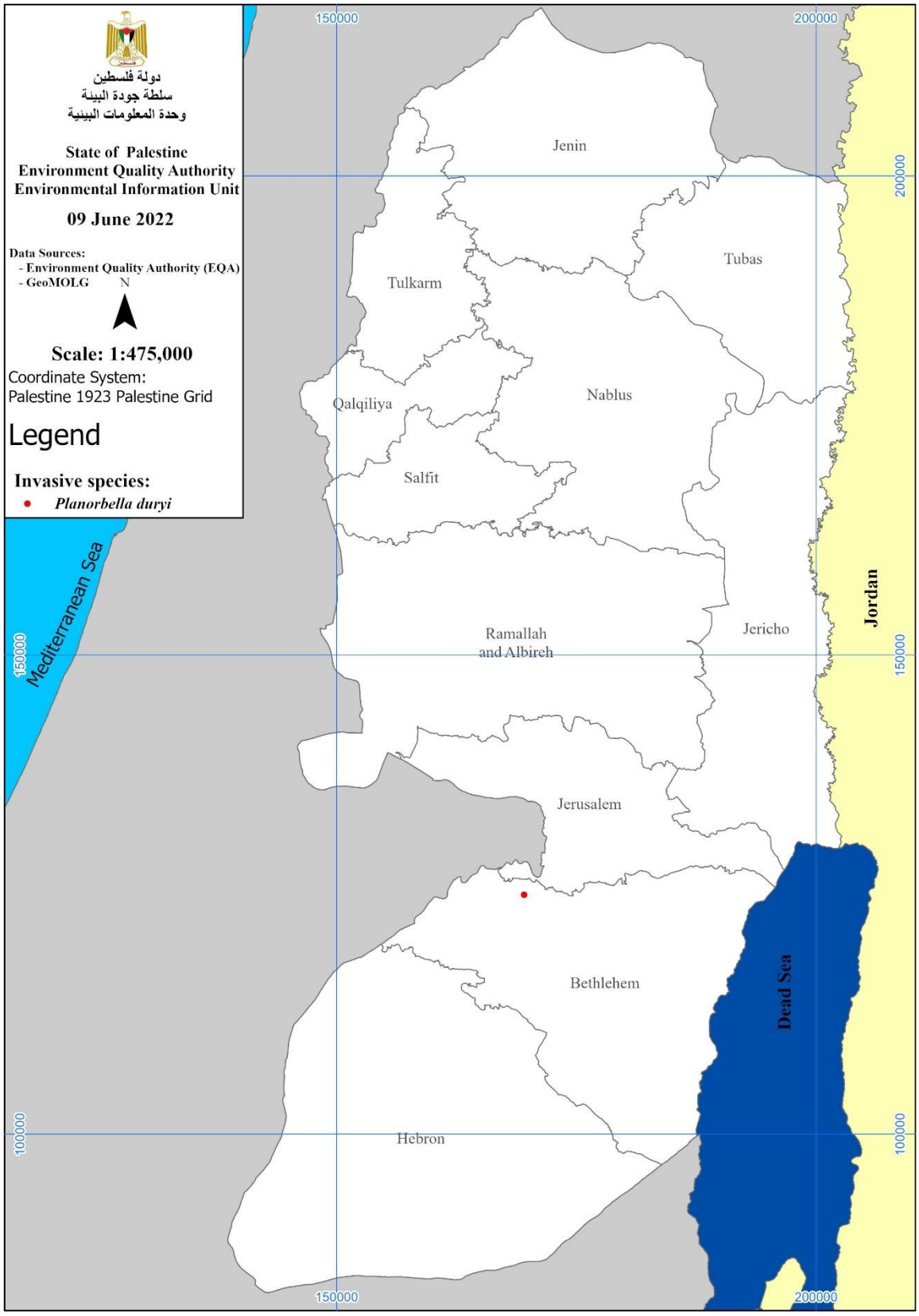
Map 17) The distribution of the *Rumina decollate* (decollate snail)



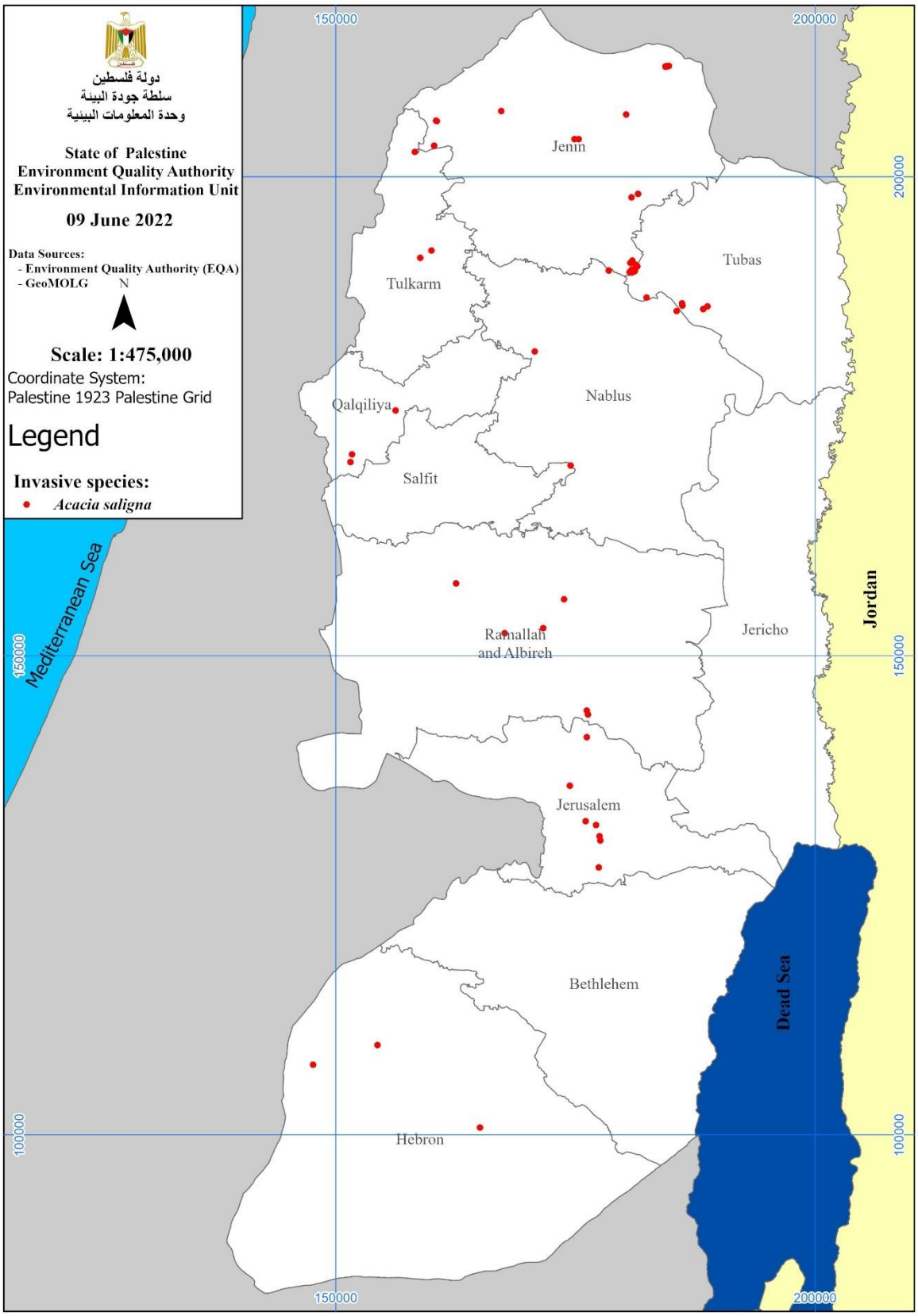
ap 18) the distribution of the *Cochlicella Barbara* (Small pointed snail)



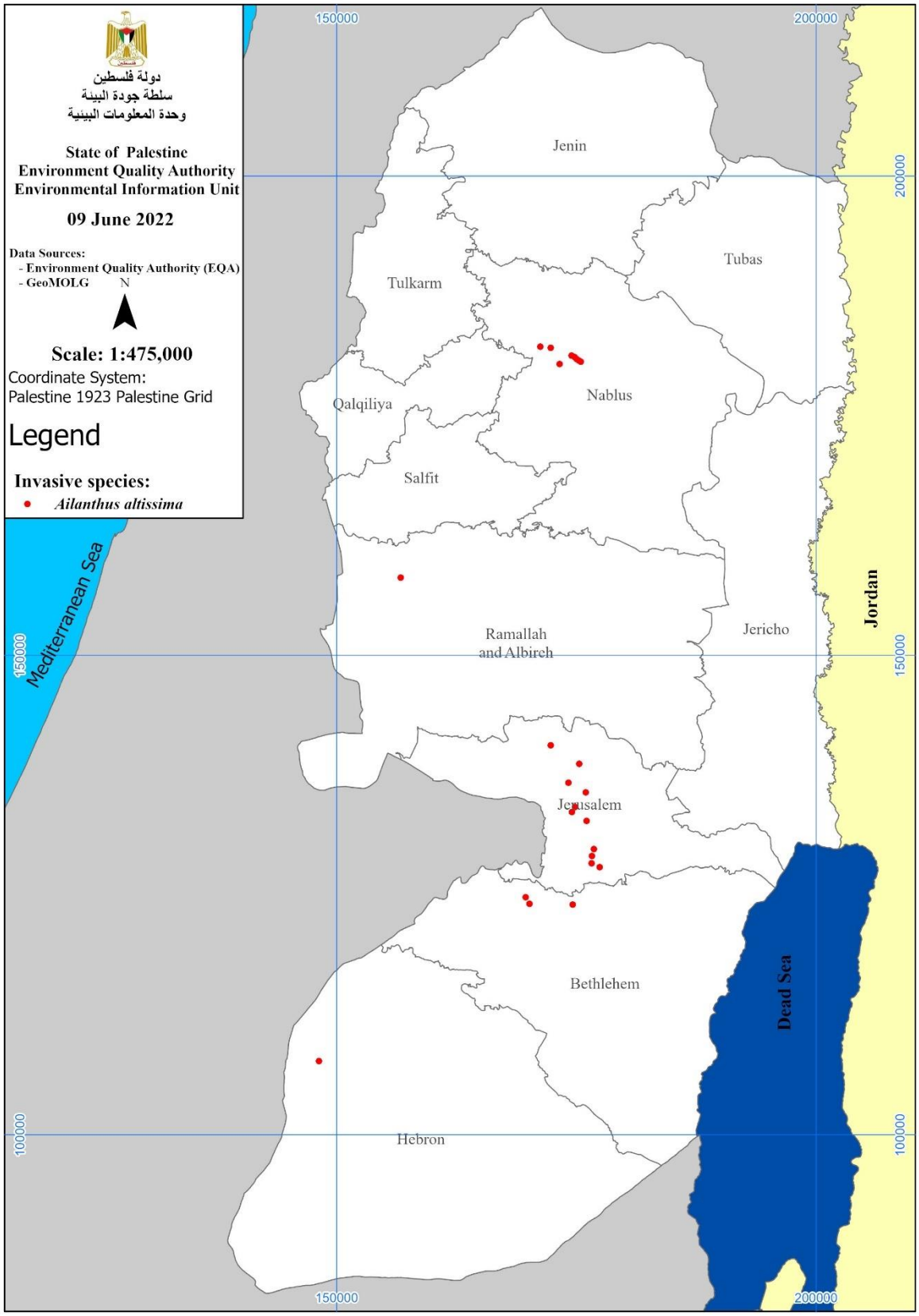
Map 19) The distribution of the *Mieniplotia scabra* (Pagoda tiara)



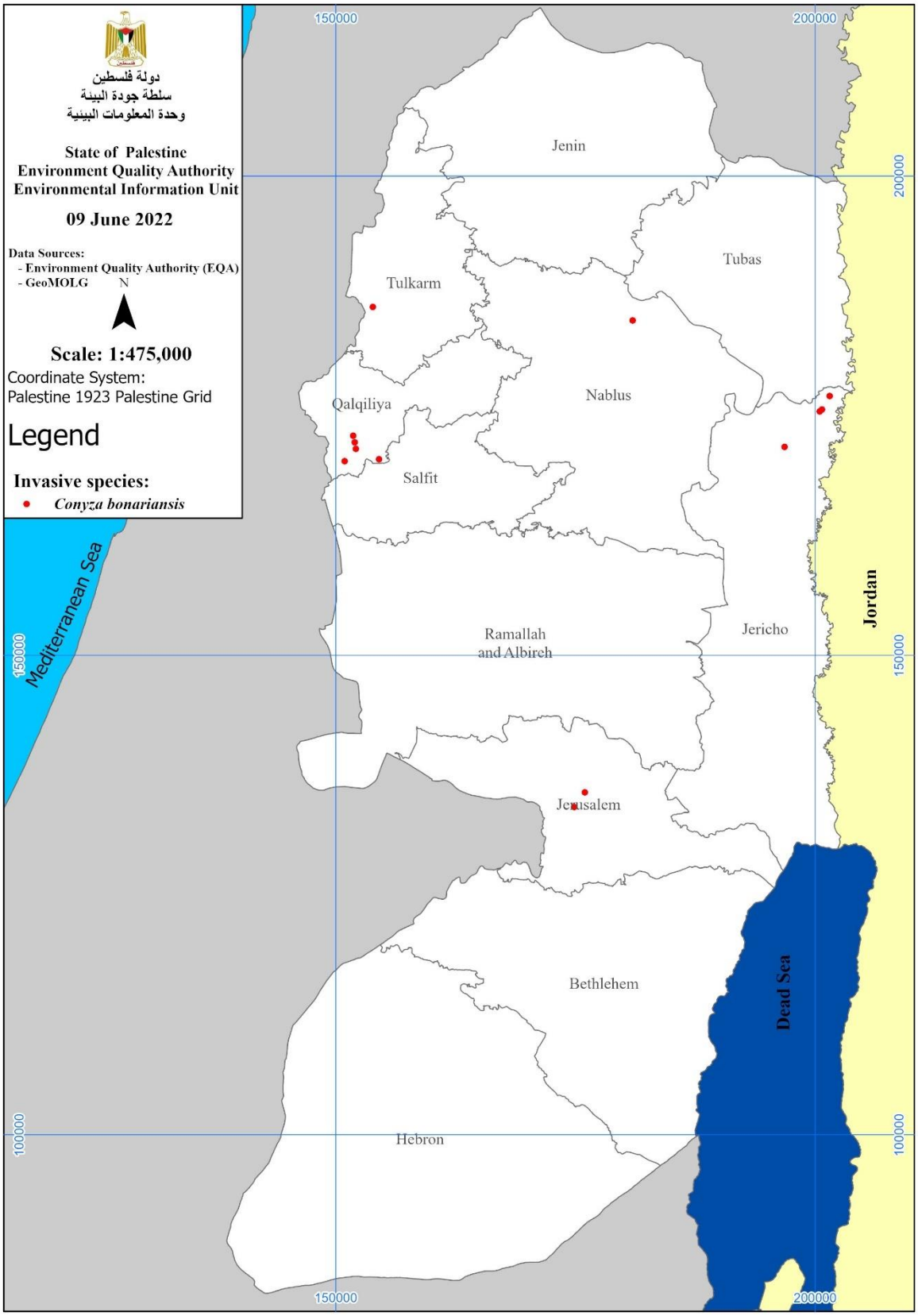
Map 20) The distribution of the *Planorbella duryi* **(**Seminole Ramshorn Snail)



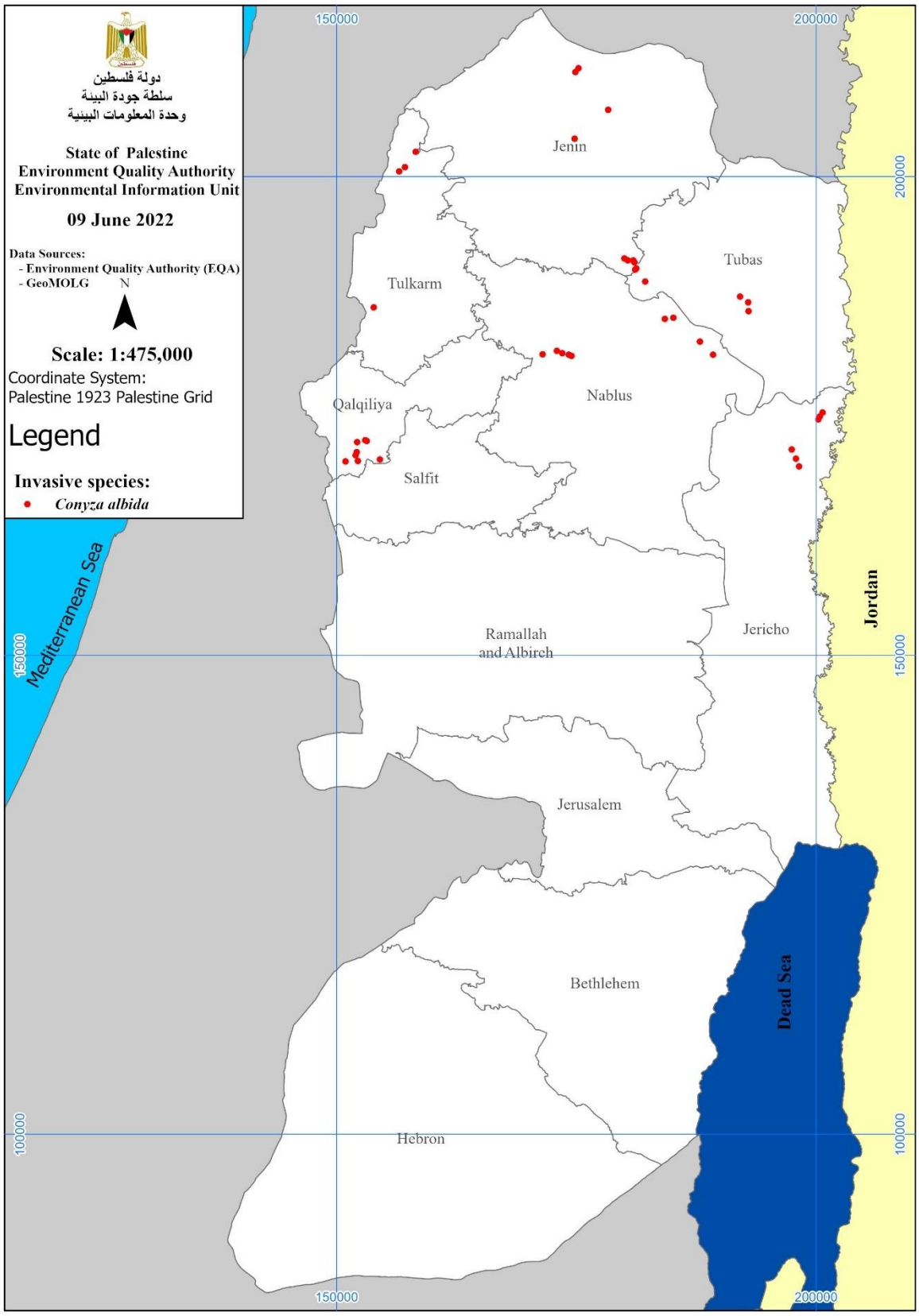
Map 21) The distribution of the *Acacia saligna* (Golden Wreath Wattle, Blue-leafed Wattle)



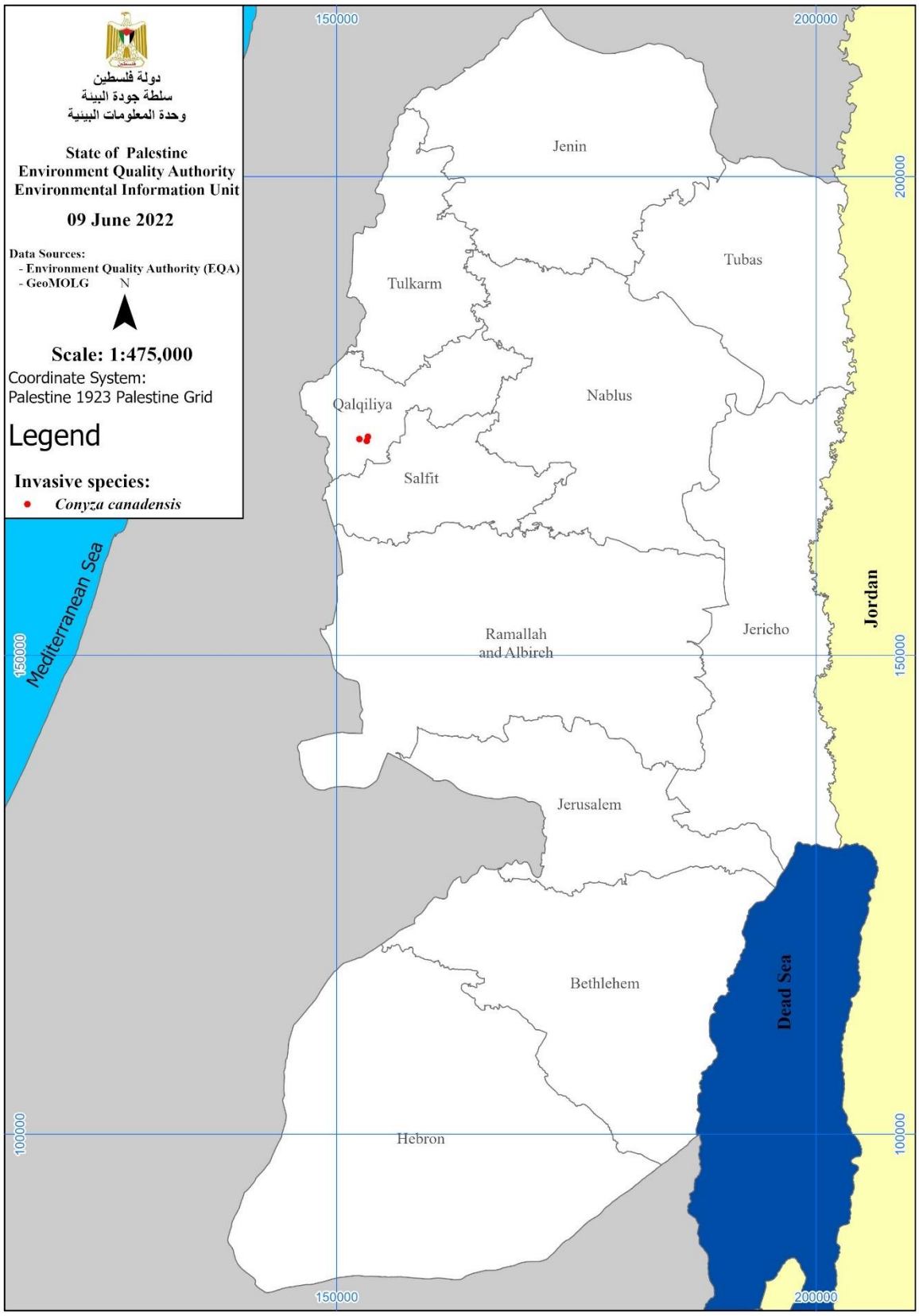
Map 22) the distribution of the *Ailanthus altissima* (Tree of Heaven, Chinese Sumac)



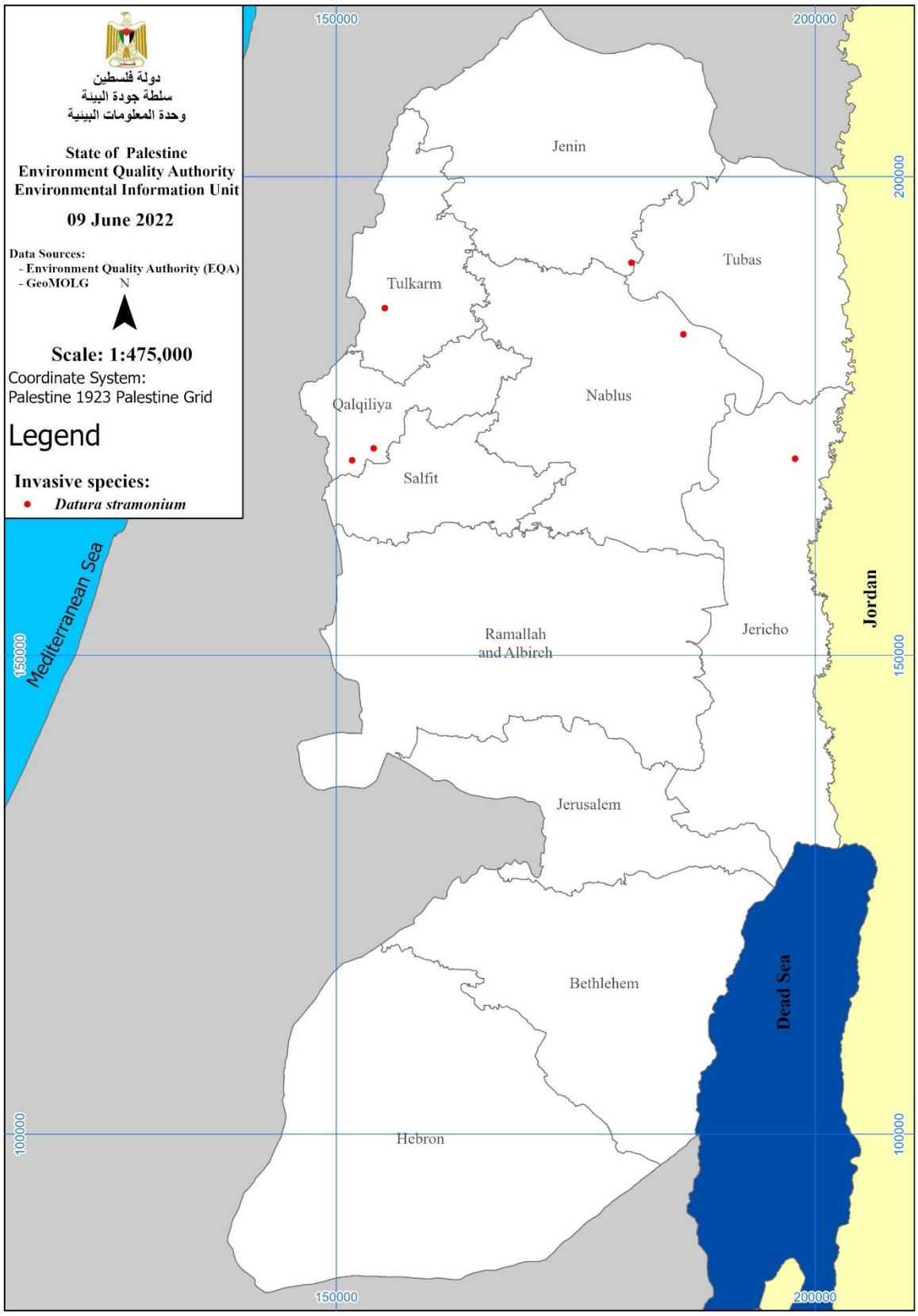
Map 23) The distributionof the *Conyza bonariensis* (Flax Leaved Fleabane)



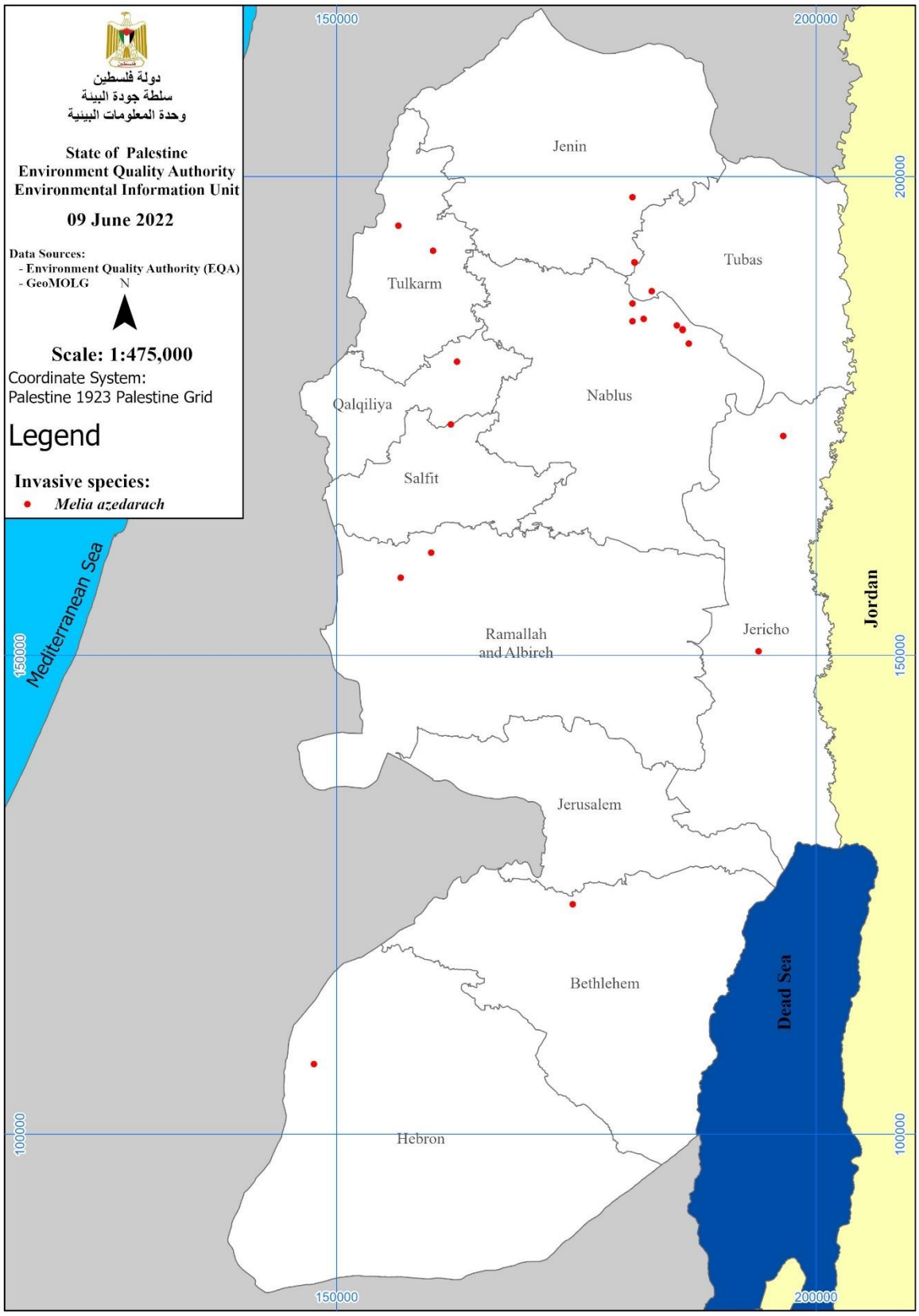
Map 24) The distribution of the *Conyza albida* (Tall Fleabane)



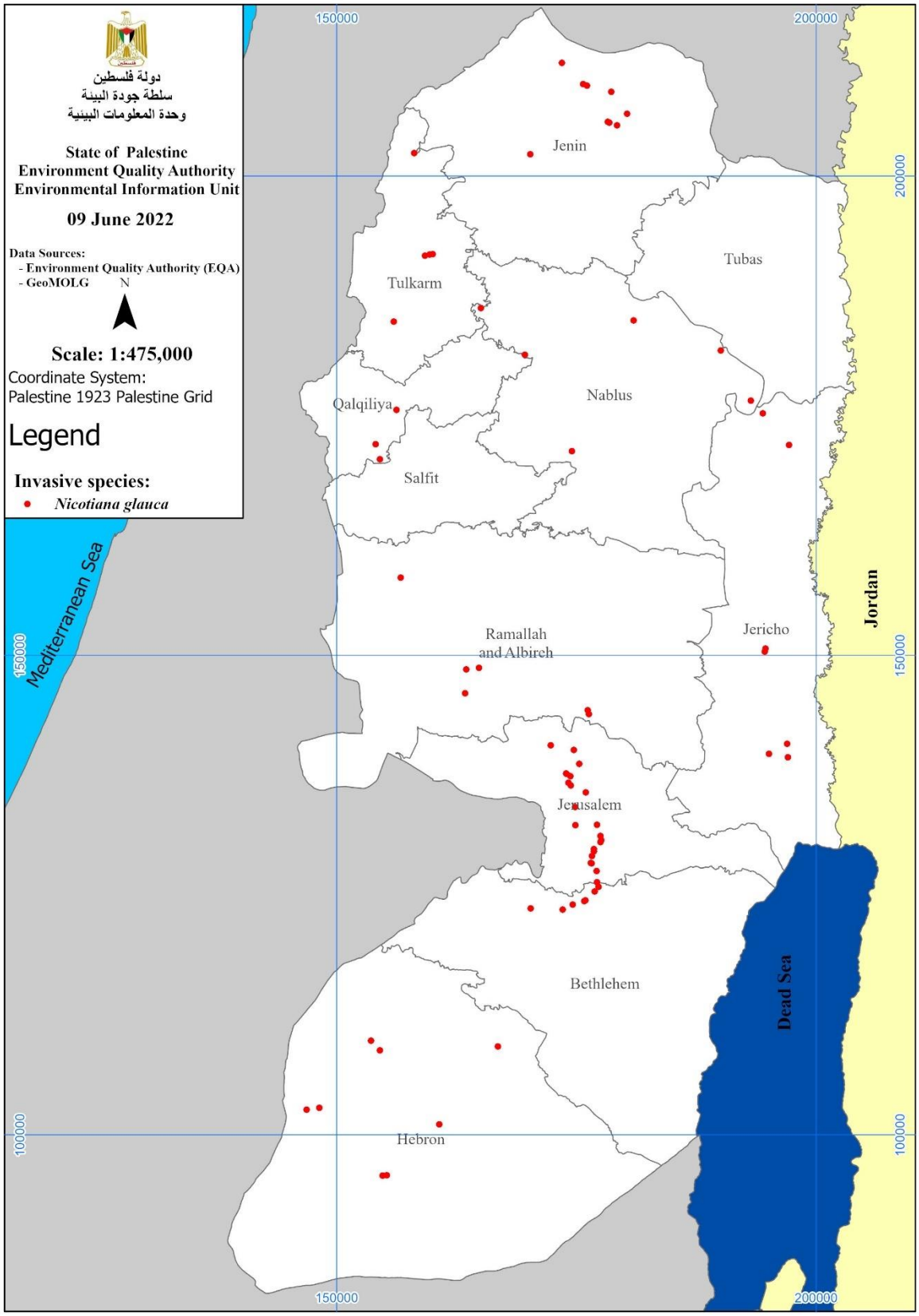
Map 25) The distribution of the *Conyza canadensis* (Canadian Horseweed)



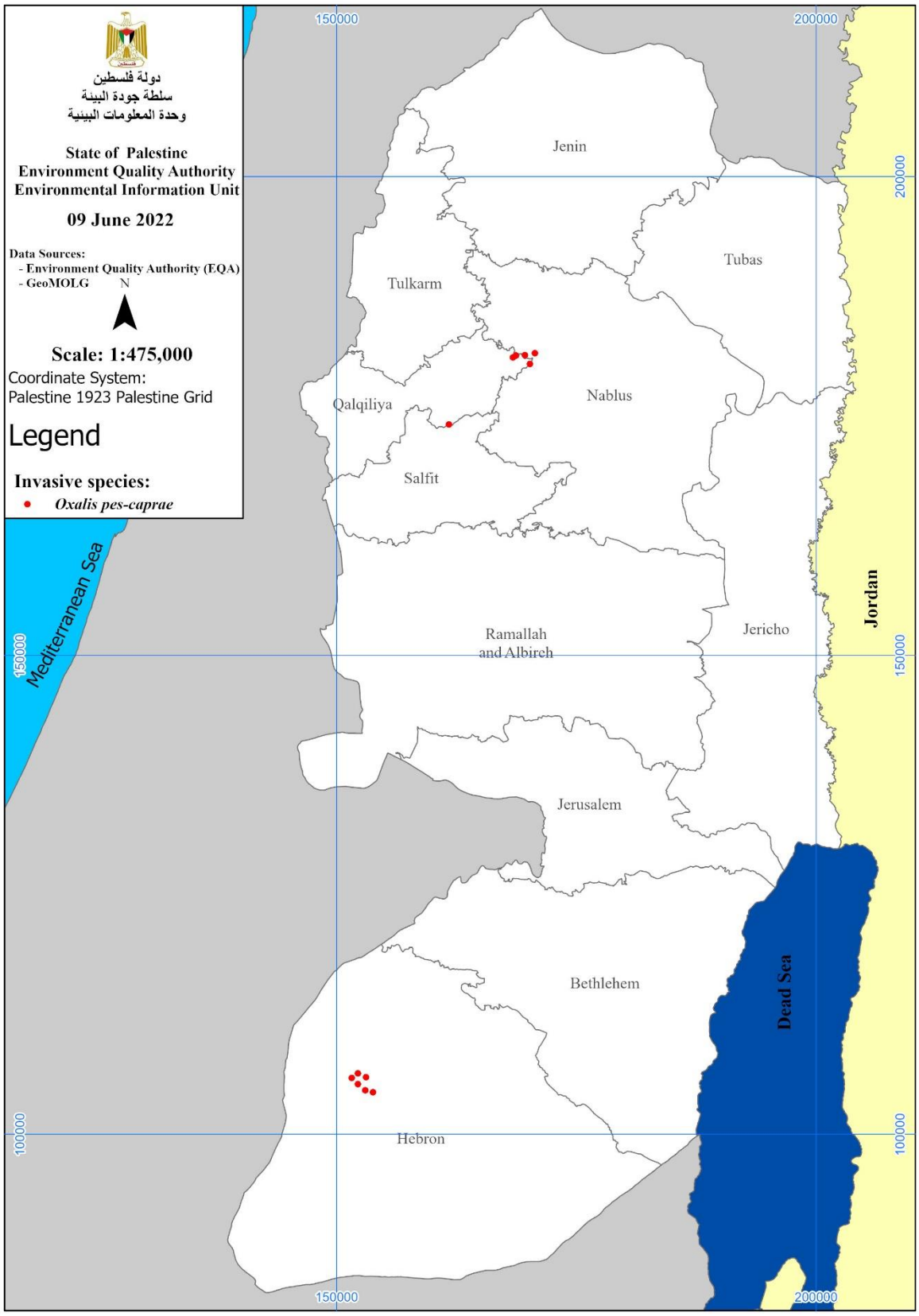
Map 26) The distribution of *Datura stramonium* (Common Thornapple, Jimsonweed)



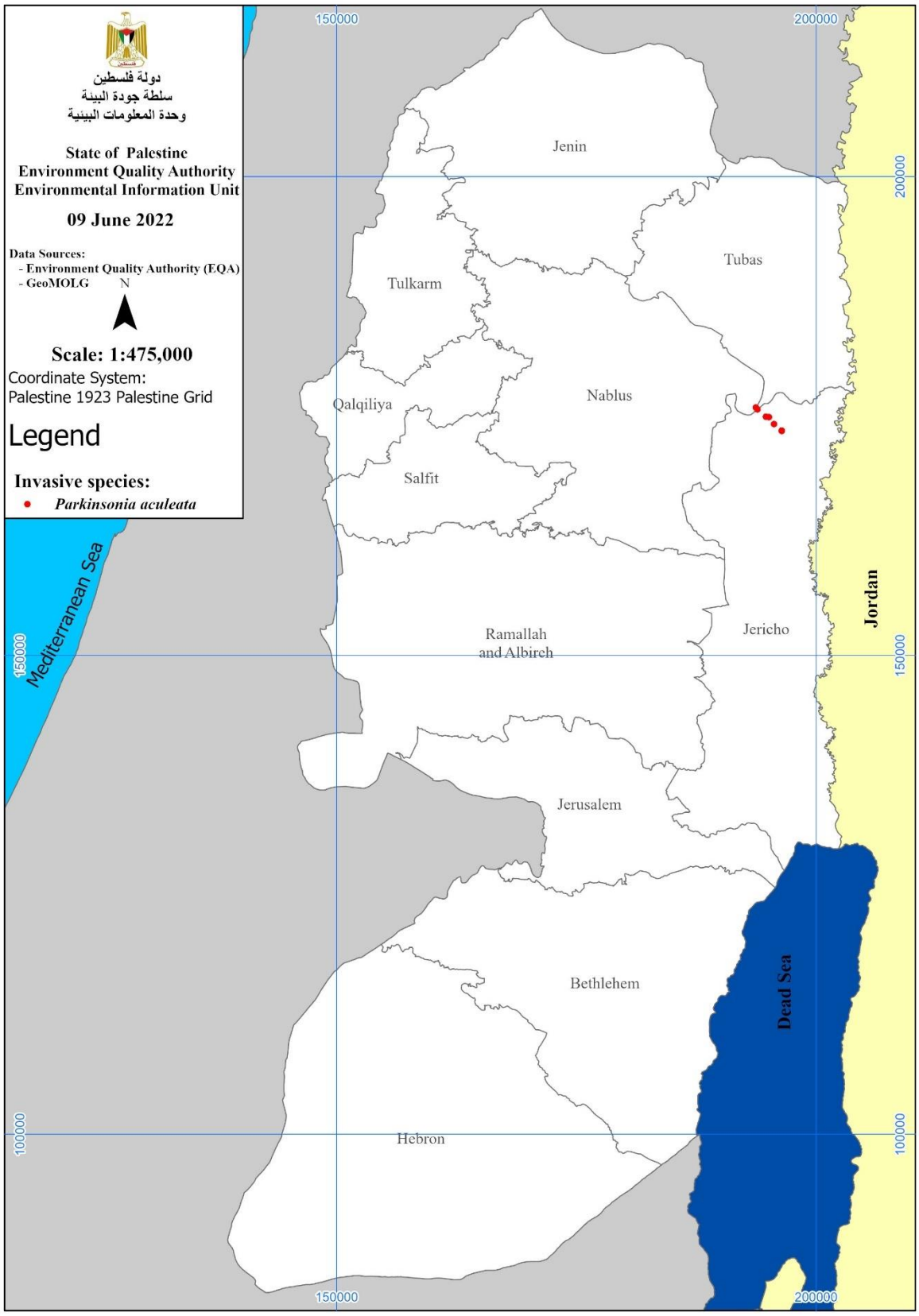
Map 27) The distribution of the *Melia azedarach* (Chinaberry tree)



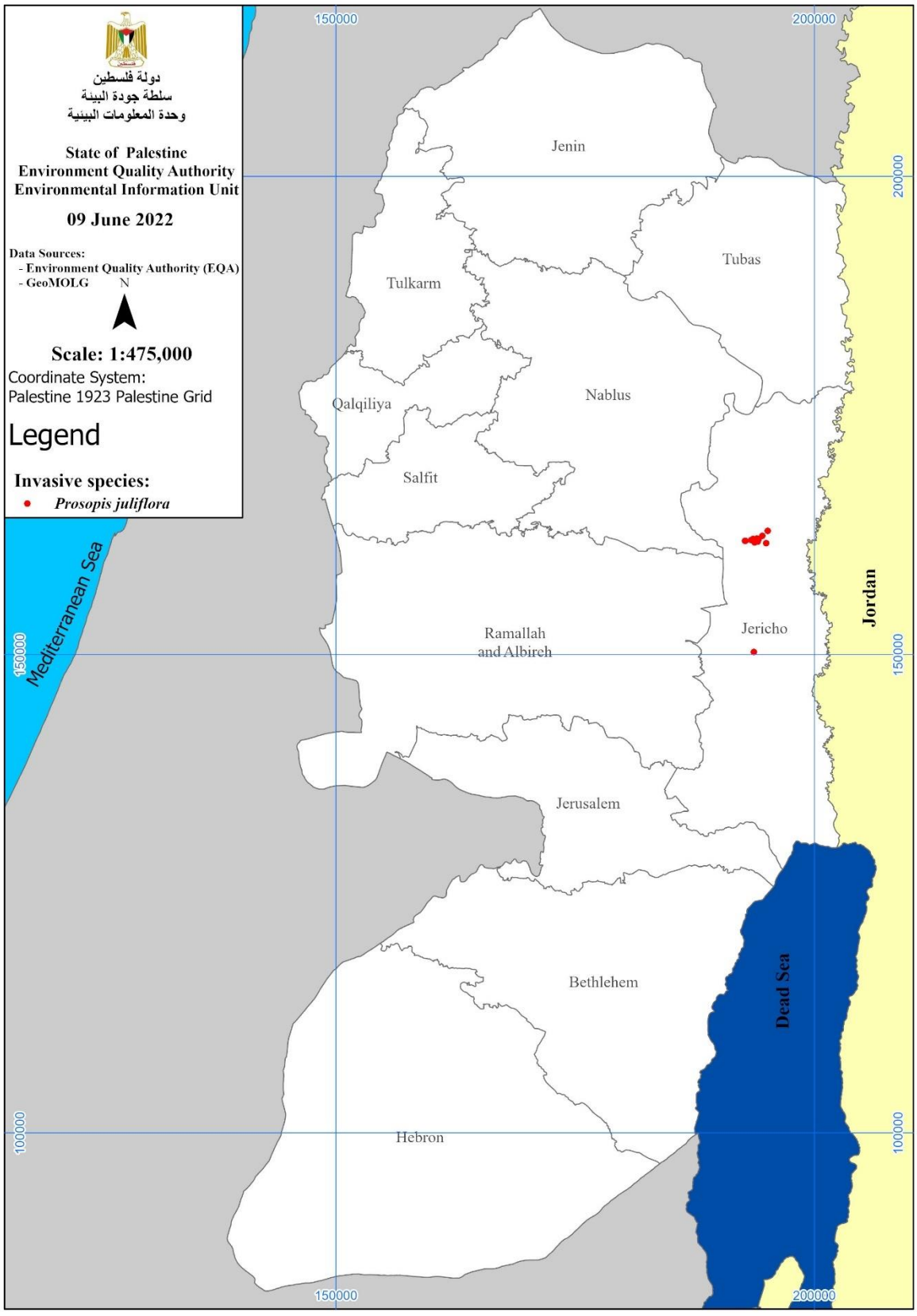
Map 28) The distribution of the *Nicotiana glauca* (Tree Tobacco)



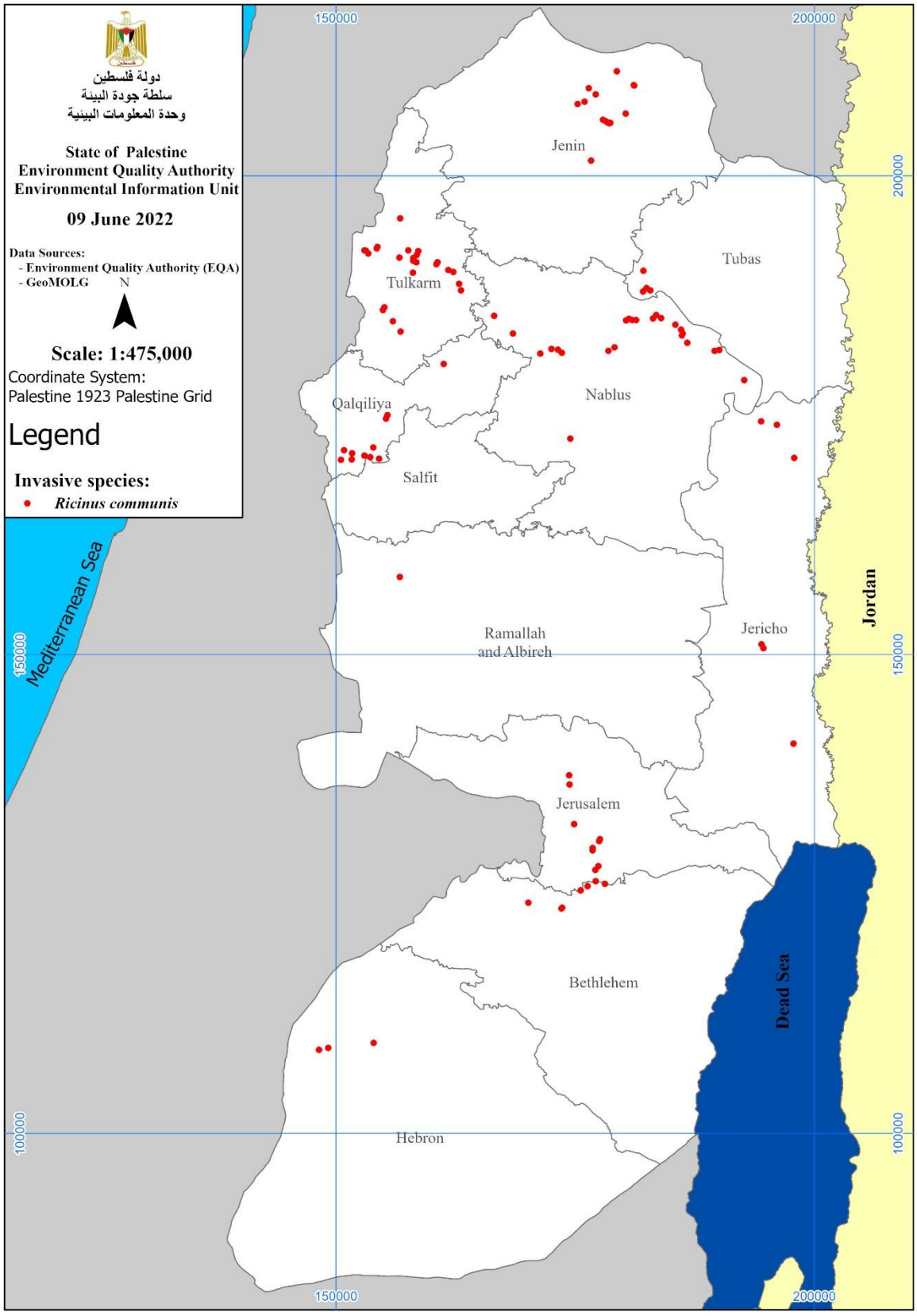
Map 29) The distribution of the *Oxalis pes-caprae* (Bermuda Buttercup)



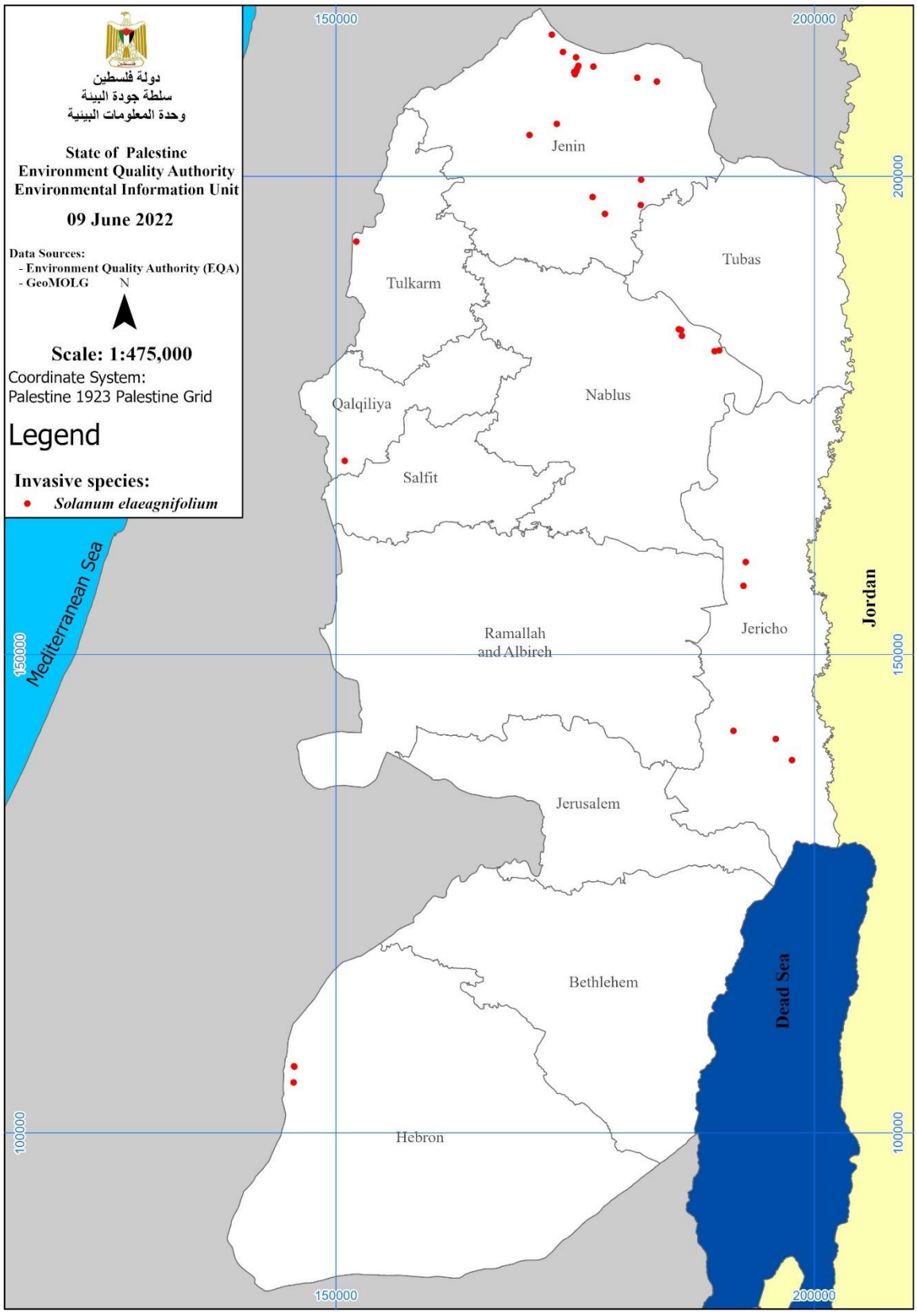
Map 30) The distribution of the *Parkinsonia aculeata* (Horse Bean, Jerusalem Thorn)



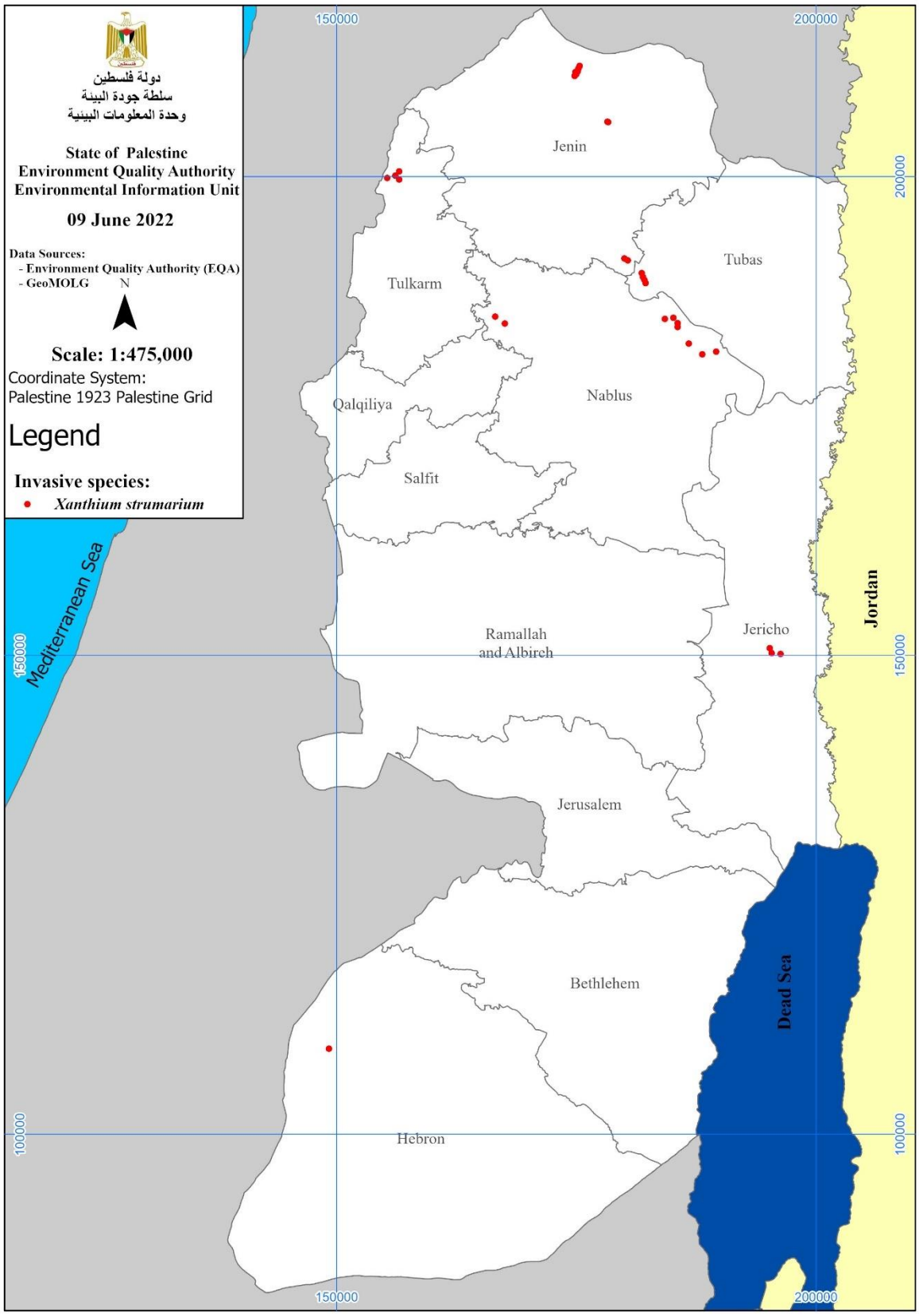
Map 31) The distribution of *Prosopis juliflora* (Mesquite)



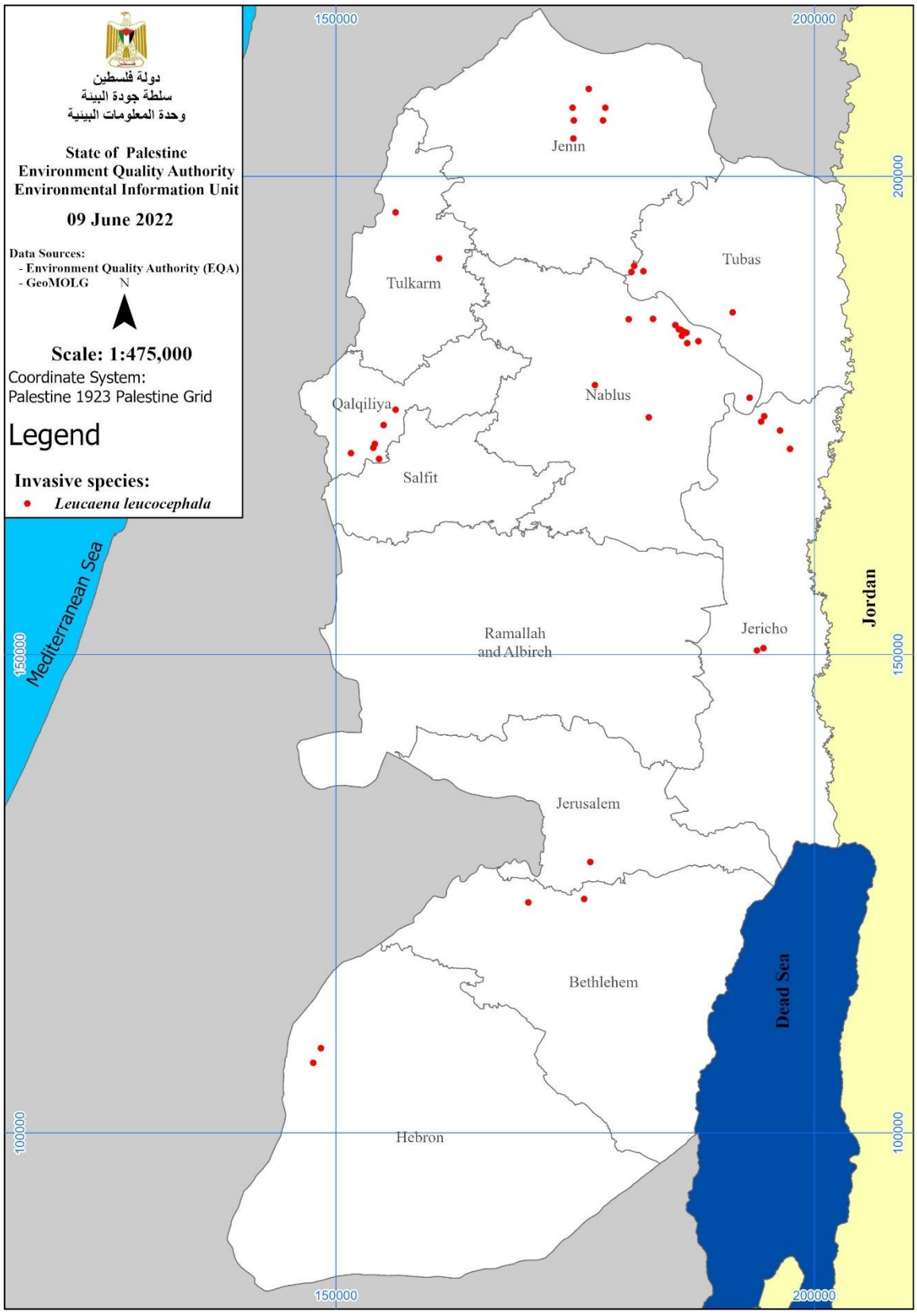
Map 32) the distribution of the *Ricinus communis* (Castor bean, Castor Oil Plant)



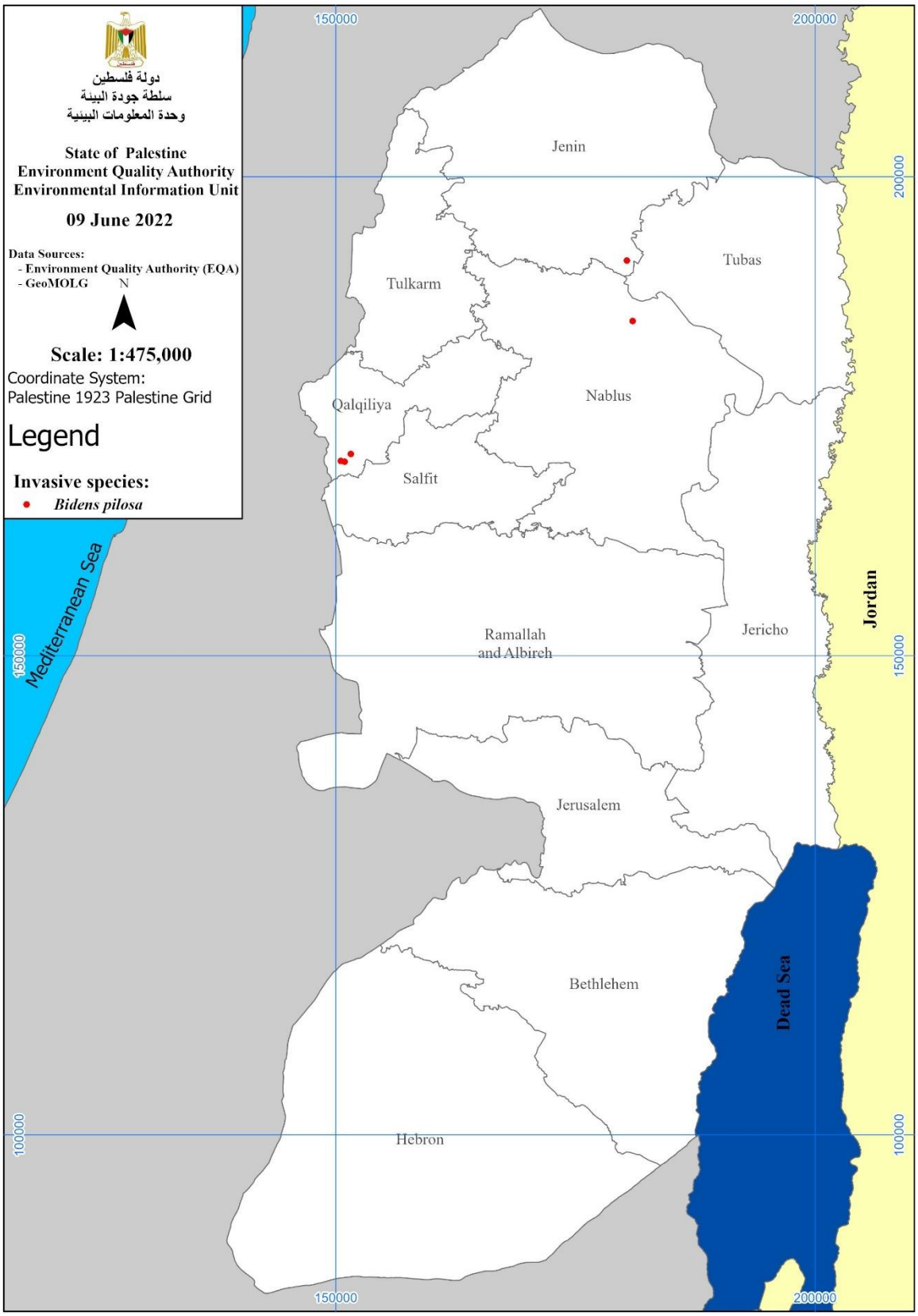
Map 33) the distribution *Solanum elaeagnifolium* (Silverleaf Nightshade)



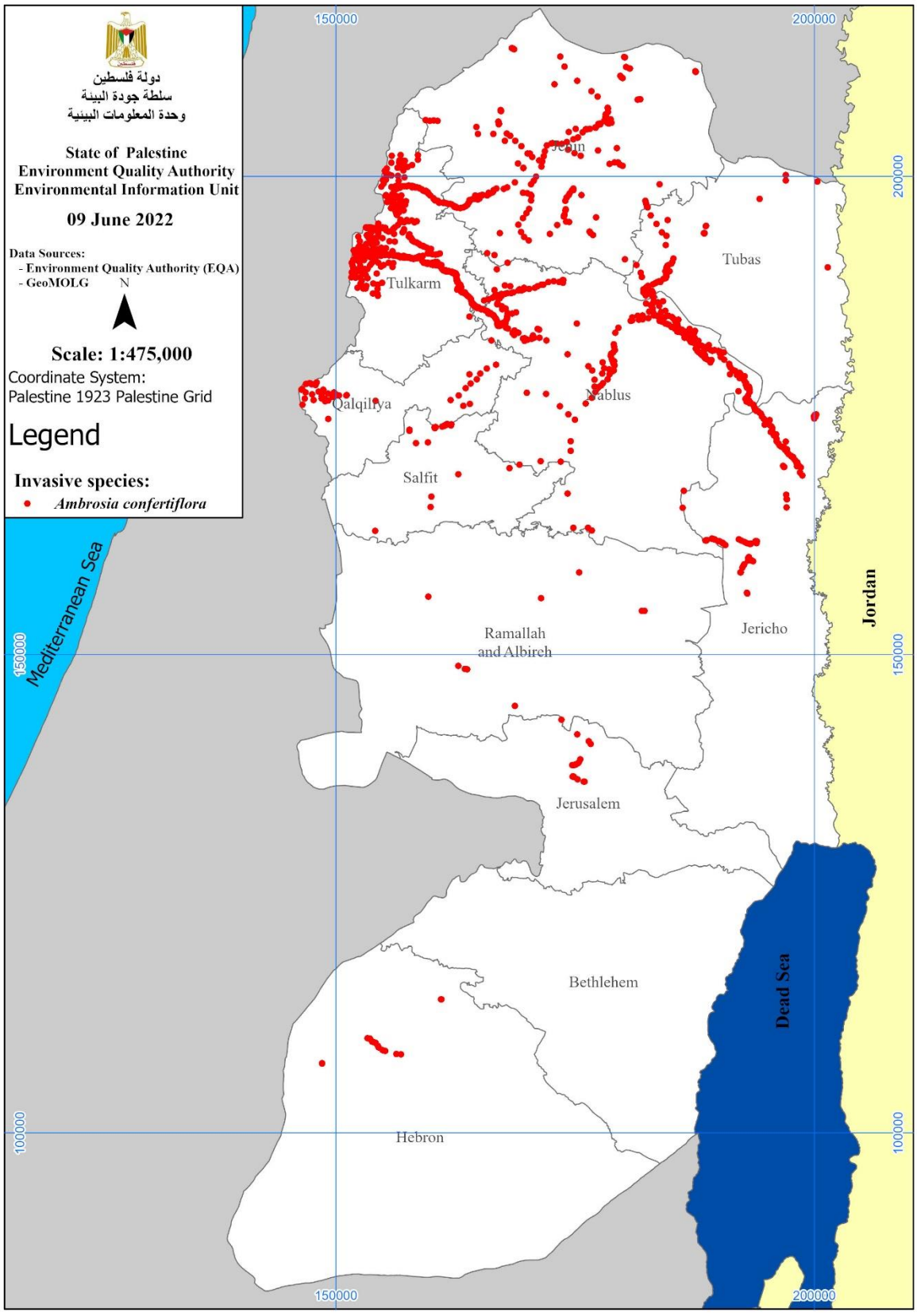
Map 34) the distribution *Xanthium strumarium* (Common Cocklebur, Rough Cocklebur)



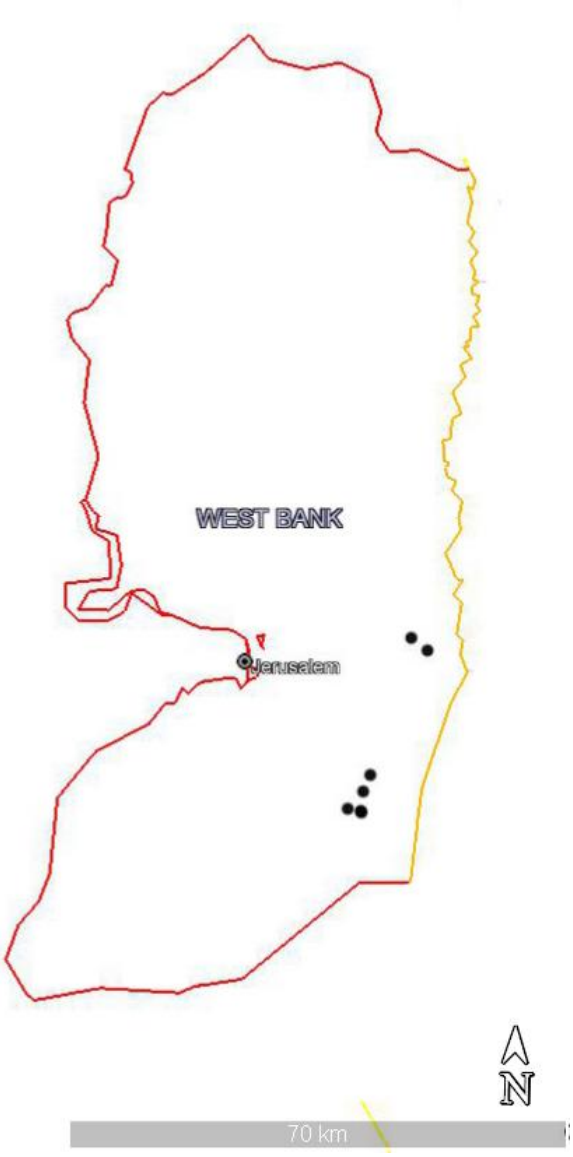
Map 35) the distribution *Leucaena leucocephala (Coffee bush, False koa)*



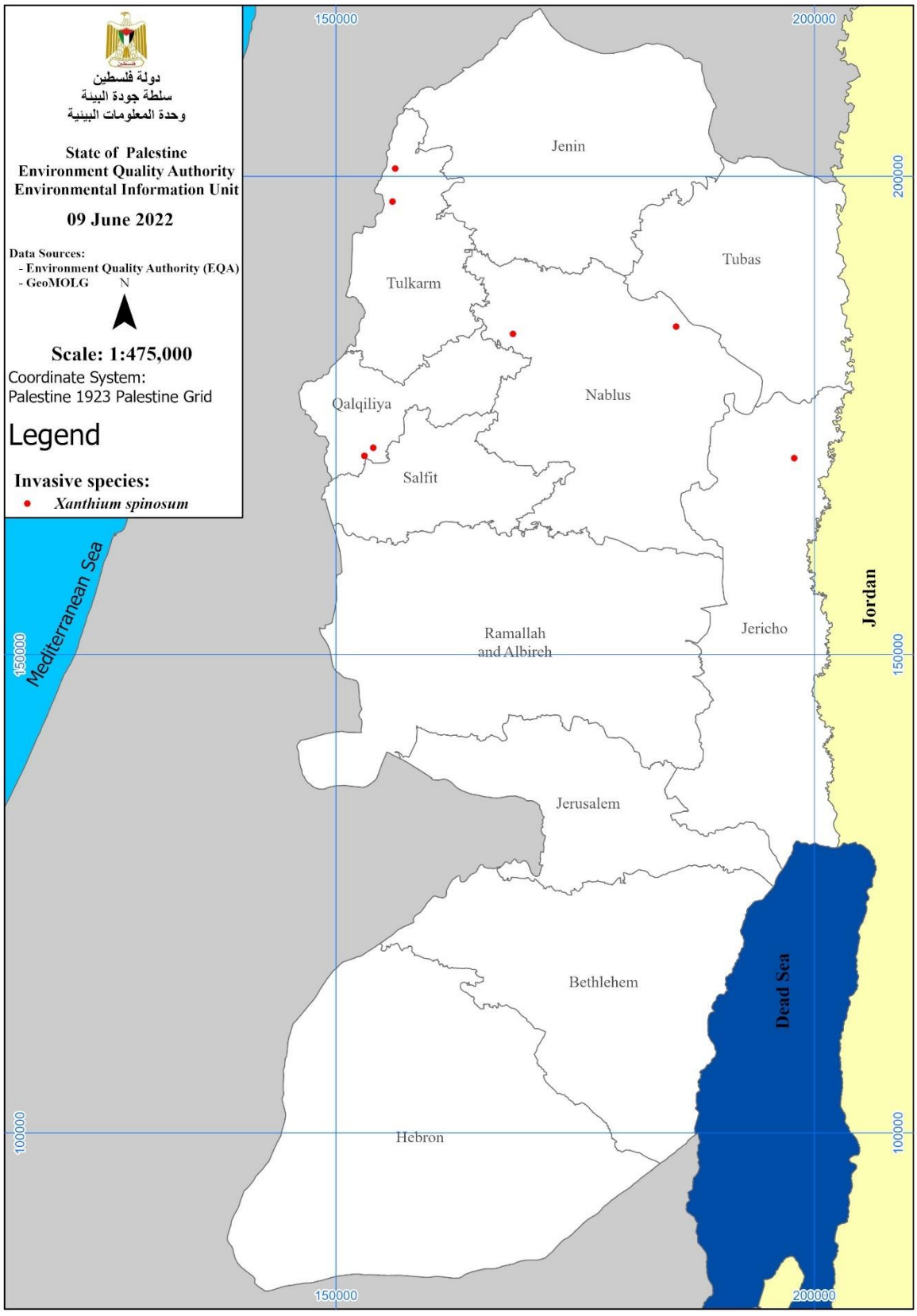
Map 36) The distribution of the *Bidens pilosa* (BlackJack)



Map 37) The distribution of *Ambrosia confertiflora* (Burr Ragweed, Slimleaf Bursage)



Map 38) The distribution of the *Atriplex holocarpa (Pop Saltbush)*



39) The distribution of the *Xanthium spinosum*