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The Black Book of Invasive Alien Plant Species of Jordan

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Introduction

Biodiversity is by far the most relevant parameter for assessing an ecosystem's condition, where higher biodiversity indicates healthy ecosystem able to perform its functions properly. Consequently, such healthy ecosystems will provide more services. Services provided by ecosystems can be divided into four main categories as identified by the Millennium Ecosystem Assessment (MEA, 2005); namely, provisioning, supporting, regulatory, and cultural. These services will directly affect the livelihood of human beings. The loss of certain services will have serious environmental, economic and health consequences. For example, loss of pollination by insects will risk human existence within years. The inability of plants to harvest solar energy through photosynthesis will lead to extinction of all higher forms of life in only 20 years. The loss of multiple ecosystem services caused by the decline of biodiversity is being evidenced worldwide nowadays (Yule et al 2013). On the global level, biodiversity loss is known to be caused by a high number of different factors (MEA, 2005, GBO2).

General impact of invasive species

The major threats to the global biodiversity are habitat loss and land use change, nutrient deposition and pollution, over exploitation, climate change and invasive alien species. As causing biodiversity loss they contribute in decreasing the resilience and leading to less functional ecosystems. Such consequence will ultimately affect human livelihoods. The impact will be more significant on vulnerable ecosystems as they do not have enough resilience to resist the negative impact of various threats. In our region the main issues threatening biodiversity are habitat change and invasion by alien species, and both have increasing trends. So any sound approach to be followed in Jordan should target both threats to safeguard national biodiversity. Several national reports listed land use change and invasive alien species as priorities, including the 1st, 2nd, 4th and 5th National Report on the Implementation of the Convention on Biological Diversity (CBD). These efforts lead to many initiatives and actions toward controlling the change in land use and to develop a comprehensive national plan for land use. On the other hand, many sporadic efforts have been exerted to tackle the issue of invasive alien species that didn't reach a comprehensive and national level.

Invasive alien species (IAS) in Jordan

As a definition, to be invasive, a plant species should be alien, and have been introduced by human to a new area that is out of its natural range of distribution, where it settles and starts spreading, at the same time it should cause clear or potential threat(s) to native species and their ecosystems. Changes in species composition as a result of alien plant invasion could change ecosystem functions such as nutrient cycling, water availability, and fire regime, which can then lead to further changes in plant community structure.

An invasive alien species is defined by the CBD, as "alien species that are non-native to an ecosystem, and which may cause economic or environmental harm or adversely affect human health. In particular, they impact adversely upon biodiversity, including decline or elimination of native species through competition, predation, or transmission of pathogens and the disruption of local ecosystems and ecosystem functions".

In Jordan, the introduction of alien plants for the sake of greenery and forestation purposes has been a major source of invasive plant species affecting the natural ecosystems. Those plant species established populations that eventually eroded or would eventually erode the natural capital and compromise the general stability of the ecosystem. Indeed, after habitat destruction, the biological invasions are wildly recognized as the largest global threat to biodiversity.

The base of management of invasive plants in a certain geographical area is information about the main species to be designated as invasive species according to adopted preset criteria, and then prevention and control measures will be established accordingly.
The first step toward tackling the problem in Jordan was to compile a list of unwanted alien plants to be a tool to the technical custodians of the ecosystems such as conservationists and a reference document onto which landscape governors and decision makers could build their future plans and policies.

The main objective:

Prevent introduction and use of any plant species (including propagules) that has a high invasive potential and/or pose a threat to the natural ecosystem in Jordan.

Note: Plant species or subspecies identified as weeds that are restricted to cultivated areas are not considered here and need further elaborated endeavor. Providing, in many cases weedy specie could penetrate the natural ecosystems whenever disturbance is there and there is a wide overlapping area between what is known as alien invasive and weedy species.

On the national level, an undertaking has been initiated to tackle this growing problem of alien species designated as invasive in various local habitats as measures adopted to protect local biodiversity as well as part of Jordan's commitment to the ratified international conventions like the CBD and the Aichi target 9 and SDG goals (article 17.9)

Approach:

In late 2017 a summary report was issued as a resolution of technical meetings of a range of plant specialists representing local ministries, NGOs and universities discussing the growing threat of the invasive and alien species in Jordan with an aim to reach a policy document to be submitted to the planners and local authorities on the use and precautions of lien plants. However, lack of information regarding the issue was a major challenge, for this most of the information gathered based on the practical knowledge of the experts involved and their personal observations, guided mainly by the biogeographic approach to stipulate that an alien plant species designated as invasive in a certain geographic region, likely to be invasive in other region which experiences similar climate and edaphic conditions. However, in order to be objective, certain criteria were set to help assessing and prioritizing species targeted; like adaptation, propagation, and its effect on host communities and ecosystem services. Depending on pre-assigned categories in the literature defining stages in similar conditions; the scope of this document will be restricted to the species threatening the natural ecosystems and not the disturbed agricultural land and/or species exclusively occurring in urbanized areas.

Weight of invasive plants amongst others:

Out of 50 plant species identified as aliens to the local ecosystems, 10 are potentially invasive, as per their referenced history of invasion or local records in Jordan. In fact most of the plant species designated as potentially invasive have not yet expressed their invasiveness; however, they might need time to reveal the success of establishment or might be waiting for a suitable modification of the natural habitat. On the other hand, some have already expressed their ability to invade and reached population peaks in some localities in the wild like *Prosopis juliflora* that has been introduced basically for greenery and aesthetic purposes. On the other hand, some designated invasive species were introduced by contamination of seed pouches; for example, *Solanum elaeagnifolium* started in the farmer's fields then is being spread out to the wild.

Practical recommendations for using the list:

The list of designated priority species is a tool to prevent and/or organize the use of potentially invasive plant species as a street tree or in afforestation programs. Defining the stages of invasion is an inevitable step to prioritize action, such stages includes casual occurrence, naturalization and finally invasion. Therefore, the introduction of any alien species by any organization or the general public or for any reason should be subject to requesting in advance to be examined by the relevant governmental authorized directorate. Any species in the designated priority species list should be banned. All decisions should count the scientific names only and not the common names. Following are sketches on the different attributes relevant to each of the 6 designated priority species as invasive or potentially invasive in Jordan.

Factsheets of the six top unwanted species (ranked)

Scientific name: *Prosopis juliflora*

Family name: Leguminosae

Common name (Arabic): السلم

Common name (English): Mesquite

Center of origin: Mexico, Central and northern South America.

Local and regional distribution:

Prosopis species are salt and drought tolerant with deep roots which tolerate dry as well as waterlogged soils. Seed production is prolific. Trees rapidly form dense thorny thickets that reduce biodiversity (Weber, 2003). The main limiting factor restricting suitability appears to be low winter temperatures (EPPO, 2018). On the regional level its distribution includes Iran, Iraq, Jordan (Fig.1),

Fig1, *Prosopis juliflora* in Joran valley, photo by K. Abulaila.

Palaestine, Kuwait, Qatar, Saudi Arabia, Oman, United Arab Emirates and Yemen. Locally, in addition to the native noxious weed prevailing the vast majority of cultivated land in the Jordan valley, *Prosopis farcta,* it is *P juliflora* a well distributed tree all over the strip from the north to the south of Jordan valley including the southern canyons from Wadi Hisban in the north to Wadi Musa in the south. Indeed, many trees in different sizes could be seen in the Wadis going to the dead sea like Wadi Assal, Wadi Manshalah, Wadi Hmarah and the entrance of Wadi Rum, such detailed distribution is not shown clearly in the distribution map as per the limit of the scale (appendix., map. 1a). On the other hand, the relatively rapid spread of the species in many cases is already threatening areas of established reserves as in Mujib, Fifa, in some localities in Dana reserve; Qatar and Wadi rum were an overlapping occurs with an important bird area, in addition to penetrating or approaching some designated Special Conservation Areas (appendix, map 1b).

Means of dispersal:

As many legumes, *P juliflora* reproduces through seeds that are carried in the digestive tract of feeding animals such as goats, cattle, camels and some wild herbivores. Seeds are also carried out by runoff water during rainy season.

Impact on ecosystems:

Displacement of the natural vegetation (native *Acacia, Tamarix, Salvadora and Moringa*), consequently changing habitats impacting the wild life, in addition to the loss of rangelands for grazing ruminants, losses due to access to water, illness and death of livestock due to eating pods by the sharp and stout thorns. Other impacts are loss of cropland and allelopathic effect of leaves on seed germination of other plant species especially annuals (Siddiqui, et al., 2009) as a result impact on natural plant communities (Kumar, 2014). On the other hand, in many cases the presence of short canopies provides protection (from grazing) that favors the occurrence of certain plant species to others changing the floral composition of an area (noted in Al Faisalyeh range land reserve). Dense stands can block irrigation canals, obstruct roads and block smaller trails. Loss of grass cover under canopies may also promote soil erosion. It has massive impacts upon water resources as lowering the ground water table. The tree re-sprouts easily after damage (Weber, 2003). It is only because of the habitat restriction (mainly temperature) the propagation and expansion of the populations couldn't reach the wilderness zones of some of the already designated reserves. However, penetration is always facilitated by disturbance! Normally non disturbed ecosystems are difficult to penetrate, but being well established the population on the borders or inside the buffer zone is a real threat of invasion whenever suitable conditions are there.

Management and control:

Prevention is the best, however, if no longer possible, it is better to treat infestations in a particular area when they are small to prevent them from establishing where uprooting the whole seedlings is an option. Once an a population has established control is very difficult, laborious and may not succeed because of regeneration from the soil seed bank and from cut stems.

The end solution will depend upon agreed objectives for an integrated management system that uses all means of control while also allowing some utilization. On the other hand, chemical control could be an option providing precautionary measures should be exerted not to affect the associated native flora and fauna (Dufour-Dror and Shmida, 2017; Tadros, 2015). The removal of a well established population especially if of wide occupation could end up with a new problem of invasion of other opportunistic species from the surroundings with different succession level that can take over whilst there is still the chance of re-sprouting of the root system of the removed tree. So it is inevitable an effort should be exerted in monitoring the spread of the newly formed seedlings to limit the area of occupancy and to find an efficient way of dealing with the already formed old trees.

Measures to be considered:

- Species should be included in an alert list and to be banned from sale, import and movement locally if identified or labeled as *Prosopis juliflora*.
- Regional coordination should be strengthened in order to prevent natural spreading over the borders between counties.
- Early warning mechanism and public awareness campaigns are crucial.
- Monitoring and eradication programs especially at early stages of infestation including integrated management plans.
- Prosopis thickets recently established along the wadi canyons in the Dead Sea area should be controlled without delay.
- A special attention should be given to other Prosopis species as some of them are also recorded as having very similar ecological and socio-economic impacts.
- Providing the taxonomic difficulties in identifying some specimens, skilled professionals should be consulted as well as reference specimens of confirmed taxa should be used.

Scientific name: *Ailanthus altissima*
Family name: Simaroubaceae
Common name (Arabic): لسان الطير او شجرة الجنة
Common name (English): Tree of heaven
Center of origin: China and North Vietnam

Local and regional distribution:

Localy, the vast majority of the populations occur in the road sides in the highly urbanized areas of Amman (Fig. 2; a&b)

Fig 2.a *Ailanthus altissima* many daughter seedlings surrounding mother plant in site of introduction (Amman, Ras El Ein) , photo by K. Abulaila. Fig. 2.b *Ailanthus altissima* approaching natural habitats in mountains near to the Jordan street north of Amman

roadsides to Jerash and Ajlun up to Irbid (not shown in the attached map), whilst reaching Karak in the south, and approaching in many cases the rural areas very close to and able to invade the natural ecosystems (appendix map.2a). Some other scattered trees or patchy populations could be seen in further north and south. As general, the spread of populations is not urgently threatening any of designated protected areas (appendix, map2b). As general, it is designated as one of today's most invasive species present in all cotenants.

Means of seed dispersal: Seed dispersal needs turbulent winds and able to disperse long distances to reach canopy gaps and other suitable habitats at least 100m from the forest edge (Landenberger, et. Al., 2007). It is an effective disperser and can spread rapidly in fragmented landscapes where edges and other high light environments occur. In addition, it can be propagated by clonal ramets.

Impact on ecosystems:

Out-competes native species especially in the range of its occupation. What makes it even worse is the ability of each well established mother plant to set many daughter seedlings soon when starts seed shedding reaching self sustaining populations in a relatively short period of time. Although the *Ailanthus's* main habitat in Jordan is road sides in the very urbanized areas, it approaches the borders of natural ecosystems as reaching the rural areas and country side;

indeed, it has been recorded to easily invade disturbed patches of forest ecosystem (Rebbeck, et. Al., 2017). The mostly affected floral elements at the time being are the species of disturbed habitats of the road sides, which could be very important species, mainly crop wild relatives (CWR), for example most of the crop wild relatives of the cultivated lettuce and carrot grow in the disturbed areas in road sides. The value of CWRs comes from their superb stress resistance genes that are crossable to the cultivated varieties to enable them thrive changing environmental conditions over time.

Management and control:

Monitoring populations in the road sides especially in localities very close to the rural areas. Getting-red of newly formed seedlings and seed producing trees wherever feasible.

Scientific name: *Acacia saligna*

Family name: Fabaceae

Common name (Arabic): الاكاسيا او السلم السنط

Common name (English): Western Australian golden wattle

Center of origin: Native to south-western to western Australia

Local and regional distribution:

In most of the highland's ecosystem (Fig.3)

Fig. 3. *Acacia saligna* growing in natural habitats (Balqa governorate), photo by K. Abulaila.

from north to south reaching the borders of the Badia from the east and the Jordan valley from the west, it's area of occupation in many cases reaching the wild ecosystems subject to the natural travel distances of seeds (appendix, map3a), in many cases the population's distribution already penetrates some designated reserves, proposed reserves and special conservation areas (appendix, map.3b). As regional, it can be found in Turkey, Syria, Iran, Iraq, Palestine, Saudi Arabia, Kuwait and Yemen.

Means of seed dispersal:

A. saligna reproduces mostly by seeds, however, it produces root suckers as well and an individual tree may form a clump (Whibley and Symon, 1992). Seeds are produced in a large amount and build up a rich seed bank that is ready to germinate after fire or rain; indeed, the long lived seeds can remain dormant in the soil for more than a decade (Weeds of Australia). Like most legume seed, it has been reported that seed dispersal is being occurred mainly by ants and birds; however, rodents have a (Holmes, 1990.)

Impact on ecosystems:

Although the trees are relatively short and don't reach the climax of an integrated forest ecosystem, it's effect is mainly on the understory species where the shade of the relatively wide canopy prohibits growth of the native annuals and sub-shrubs. In addition, as a legume, it has an enriching effect on soil nitrogen, which changes the natural balance of the native flora by favoring nitrogen loving species in areas of occupation. In addition, it out competes the native species for nutrients and water.

Management and control:

Physical cutting as well as chemical methods using herbicides were all applied, However, their difficulty and cost led to being targeted by biological control that targets either or both the plant and seeds in the soil seed bank.

Scientific name: *Nicotiana glauca*
Family name: Solanaceae
Common name (Arabic): تمباك بري
Common name (English): Tree tobacco
Center of origin: South America

Local and regional distribution:

Locally, well spread over the neglected areas and dump places and mainly toward dry conditions and poor habitats, especially in the eastern urbanized areas from Amman to Zarqa. It can be found in many neglected areas and ruins sites as well like in Jerash (fig. 4),

Fig. 4. *Nicotiana glauca* growing in the Roman ruins of Jerash, North to Amman, photo by K. Abulaila.

this is in addition to some patches of occupation reaching to likewise habitats in the northern part of the country, neglected areas, road sides and high ways of the south from Karak to Tafilah (appendix, map.4a). However, although approaching natural ecosystems, at the time being doesn't form a real threat to the areas designated as reserves or planned to be or even special conservation areas (appendix, map. 4b), On regional level it is found in Lebanon, Palestine, Turkey and Egypt.

Means of seed dispersal:

Seeds are chiefly spread by water. Animals can act as local seed dispersers, although seeds are not specifically adapted to this dispersal method.

Impact on ecosystems:

All parts of the plant are poisonous. It has been included in the Global Invasive Species Database (GISD 2010). Nicotiana is already recorded as invasive in native habitats resembling Mediterranean ecosystem as in California. It out competes native species. N. glauca is a pioneer plant in many disturbed ecosystems and in waste dumping sites; therefore disturbed sites are of particular risk from N. glauca invasion. This is especially true as the species has potential for use in bioremediation of heavy metal-contaminated sites, and its use for this purpose could lead to the invasion of new areas. It has very high seed production and soil seed bank formation and ability to re-sprout under different drought and flooding conditions. Leachates from N. glauca leaf litter and twigs inhibit the germination of native species.

Management and control:

The best control should be exerted at earliest stages before full establishment. It is recommended to pull out the newly formed seedlings as early as possible, best before flowering. Chemical control by herbicides such as triclopyr, imazapyr or glyphosate is effective.

Scientific name: *Atriplex nummularia*

Family name: Amaranthaceae

Common name (Arabic): رغل دائري

Common name (English): Old man salt bush

Center of origin: Australia

Local and regional distribution:

Locally it is wide spread in many localities in the eastern and southern deserts (Badia) (appendix, map. 5a) where it was introduced with the assumption of being one of the best alternatives for restoration of the rangelands as part of many projects that aimed at livelihood improvement of the Jordanian Badia. Later, it's use has spread to include the south non forest Mediterranean habitats including the highlands of Tafileh and Naqab. On the other hand, it has been used as source of greenery in some main roads in Amman the capital. As per its threats to the natural ecosystems, the areas of occupancy of the well-established populations so far didn't clearly penetrate the nature reserves (appendix, map5b), however, being used in the rangeland reserves of the ministry of agriculture as well as being planted in the eastern desert have changed the surrounding habitats and niches of different levels of heterotrophy of the natural ecosystem. On the regional level, it has also been introduced to most Middle-Eastern and North African countries as a good source of grazing in the range lands because of its tolerance to various harsh conditions of drought and soil chemistry (fig.5).

Fig. 5. *Atriplex nummularia*

Means of seed dispersal:

A. nummularia produces tiny flowers during the winter and normally wind pollinated, although this may vary according to seasonal temperature fluctuations. In many cases, fruits of *A. nummularia* contain no seeds. Seed dispersal primarily occurs through the consumption by livestock such as sheep and cattle. In addition, thanks to the bracteoles (wings of the fruit), wind dispersal is always an alternative.

Impact on ecosystems:

occupation of the natural habitats of native species (changing the demography of native plant communities) and moderating the soil conditions and niches of fragile floral and faunal elements. It has a capability of occupying the disturbed habitats and usually produces seeds with different dormancy scenarios that enables long survival over time and relatively rich soil seed bank for future regeneration.

Management and control:

To stop introduction and monitor new seedlings formation and restore the natural range lands with native species. In addition to avoiding different causes of disturbance that enables ultimately expansion of area of occupancy of *Atriplex*.

Scientific name: *Solanum elaeagnifolium*

Family name: Solanaceae

Common name (Arabic): الباذنجان البري

Common name (English): Silver-leaf nightshade

Center of origin: South USA and Mexico

Local and regional distribution:

Locally, it occurs in the Jordan Valley starting from north Shuneh reaching to the Wadi Mujib conjuction, and recorded in Waleh area then some in Petra and some in Mafraq in the east, in side and surrounding vegetable cultivations (appendix, map.6a). In regard to its threat to the natural ecosystems, it occurs primarily in cultivated land then starts spreading outside and if conditions were favorable it can easily take over many of the natural elements. Indeed, it is approaching the borders of some of the areas designated as natural reserves and can already be found in some protected areas in the south (appendix, map 6b). In the Mediterranean region, *S.elaeagnifolium* tolerates steppe and mild climates with relatively high summer temperatures and low annual rainfall (250–600 mm) (EPPO, 2007), it has been reported as an invasive weed in Syria, Iraq, and Lebanon (FAO, 2011).

Dispersal mechanism:

has the ability to produce sexual and asexual propagules that travel long distances. The fruit can float and can be dispersed along rivers and streams, especially, during floods. In addition, it is capable to endure considerable drought and to dominate shallow-rooted vegetation, especially

during summer dry periods and of high capacity to suppress valuable species. Although the plants die back in winter, ripe fruits are retained on dead branches and may be dispersed by wind. Dried plants may also blow like tumbleweeds, spreading seed along the way.

Impact on ecosystems:

It has the potential to invade ecosystems and out-compete native flora by forming closed colonies. It is designated basically as an agricultural weed, however, it reaches the edges of the natural ecosystems like range lands and water canals. It may replace natural vegetation in areas of overgrazed rangeland, and has been recorded as serious threat in some well known biodiversity hot spots. The plant can adapt to different soil types. It forms monospecific stands and it is not considered to be affected by competition with other plants. The berries of *S. elaeagnifolium* are toxic to live-stock, particularly when ripe; toxicity symptoms include excessive salivation, nasal discharge, respiratory complications, bloating, trembling and diarrhoea. The plant affects horses and causes mortality to sheep. It is a host of several important agricultural pathogens and pests, and can be regarded as an environmental pollutant with negative impacts on crops, livestock, the environment, crop yields, and marketing.

Management and control:

Measures to prevent entry of the plant through international trade should be taken. There should be specific import requirements for *S. elaeagnifolium* to be included in the phytosanitary regulations. Such preventive measures should be established in countries at risk before the plant is too widespread to be managed efficiently. The plant is known as very difficult to manage once established. Eradication is possible only for early infestations. In case chemical management is the only choice, control by applying translocated herbicides requires precise timing.

Fig.6 *Solanum elaeagnifolium* in Waleh area in water streams, photo by K. Abulaila.

Recommendations

IAS are amongst the most serious threats to the integrity and sustainability of natural ecosystems all over the globe. Therefore a holistic collaborative approach should be adopted on the regional as well as global levels to address the consequences of the wide spread of the IAS especially in the natural habitats. Controlling introduction and proper management of already existing populations are priorities. Capacity building and raising awareness of institutions, policy makers and local inhabitants are inevitable. Generally the intervention should be on technical, regulatory, social, and economic levels;

Technical:

- Identification of the problem starts from listing the pioneer species to be targeted in Jordan and the region. Literature and field experts could be a good source of information
- Identification of the sensitive areas or ecosystems to each particular species and expected threats
- Develop an interactive early warning to address different up to date threats supported with field data and using remote sensing approaches.
- Prevent the introduction of any species identified as invasive through the borders, regardless of the objective of importing this species.
- Encourage studies and data collection on ecological requirements and propagation dynamics of the different invasive species including threats and impacts such species exerts on its area of introduction and occupation.
- Invest in developing appropriate methods to control infested areas bearing in mind the specialty of each particular ecosystem targeted.

Regulatory:

- Carry out an inventory of all legal frameworks already set to address IAS and their status of implementation and the relevant gaps.
- Put into effect the implications of the global conventions and agreements ratified by Jordan as well as the experiences of neighboring countries or countries with similar habitats and conditions in framing the regulations needed to compact current and future threats.

Socio-economic aspects
Social:

- Define the effect of changing the vegetation cover as affected by the spread of IAS on different aspects of social lives of local communities; including their traditions relevant

to their awn surroundings like grazing animals and collecting wild edible and medicinal plants.

- Determination of the most affected communities and the way of controlling the adverse effects and the chances of making use of the already established IAS plant communities for the benefit of the local societies.

Economic:

- To inform the relevant authorities about how the introduction and spread of IAS have direct and indirect effect on the local economy currently and on the long run.
- Mainstreaming of the relation of IAS to the natural ecosystems and its services with monetary figures highlighted.
- Encourage studies and research on economic impacts of introduction of IAS and relevant tradeoffs upon different management alternatives.
- Develop a rough yet comprehensive economic analysis of IAS to be submitted to policy makers. This will help to inform them about the overall impact of IAS in Jordan.

Awareness raising & capacity building:

- Raising awareness on different levels about the current threats and future impacts of IAS in Jordan especially in the fragile habitats; giving local and/or regional examples.
- Inviting the local private sector to participate in technical orientation events to raise their awareness. The focus should be on the effect of bad practices in the agricultural sector that lead to the spontaneous invasion of species planted for other purposes.
- Capacity building and empowerment of the staff of local relevant authorities (mainly the municipality taskforce) to enable them to deal with the issue of IAS technically and legally.

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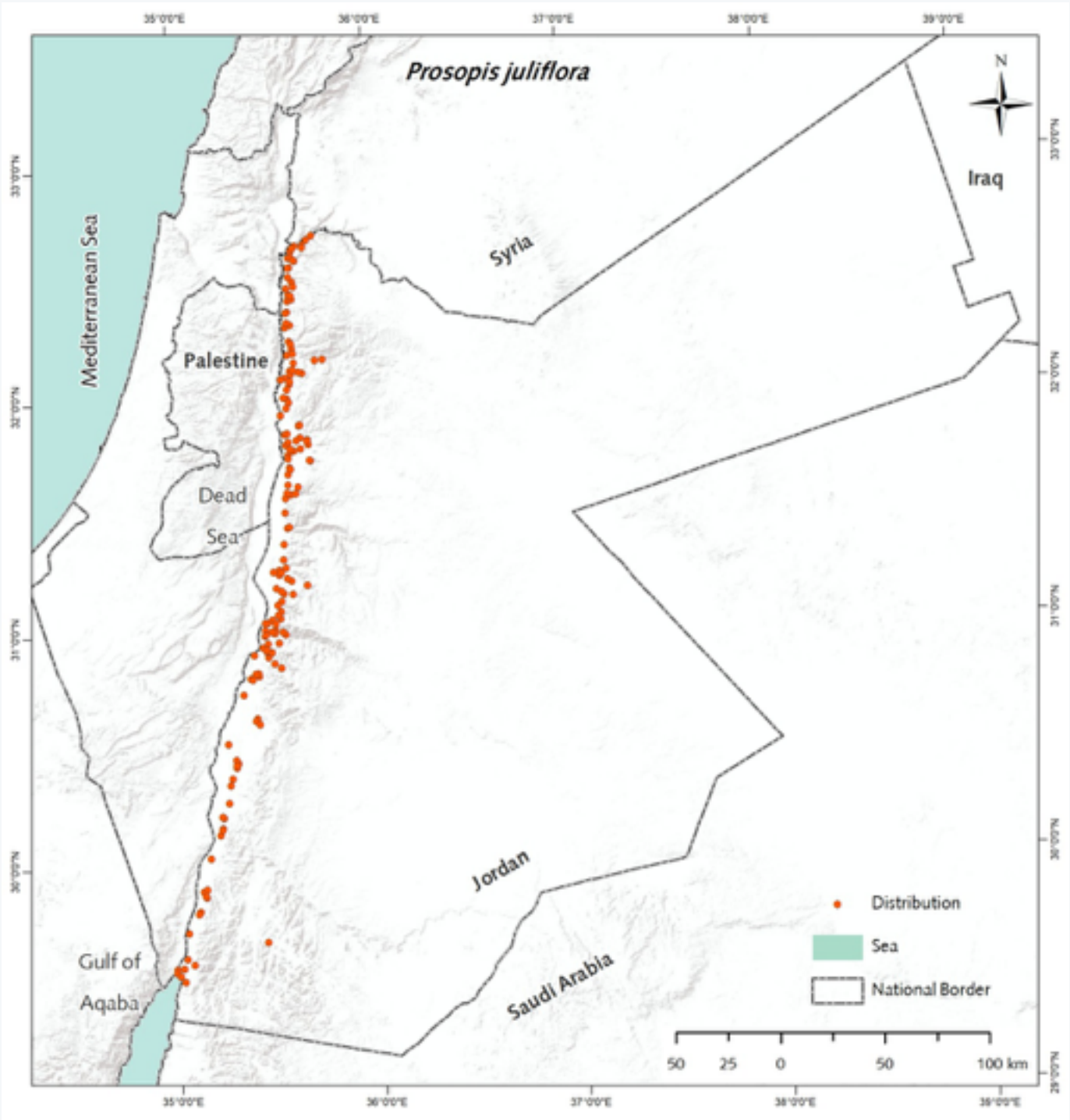
Appendix.

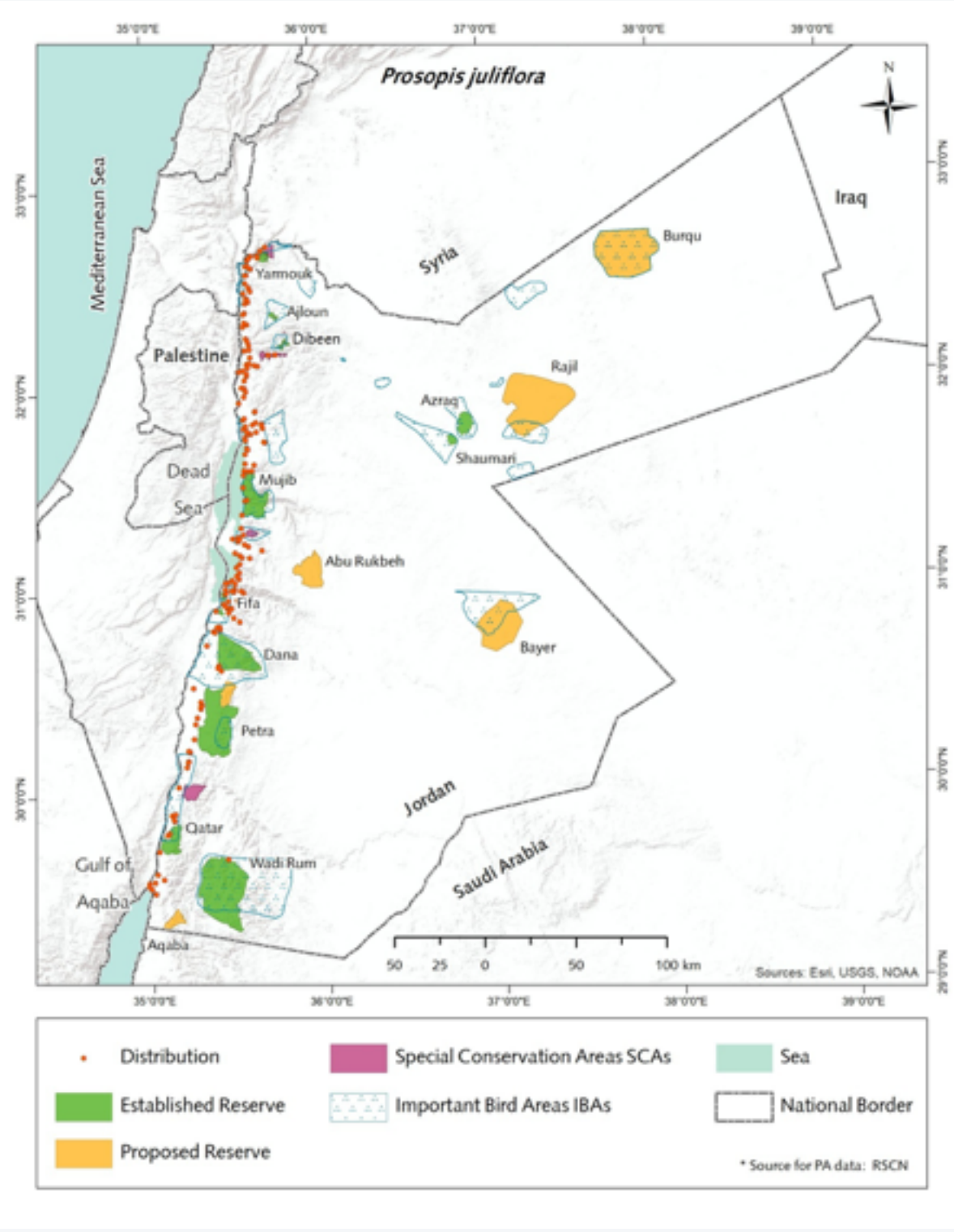
Maps of species distribution as whole (a) and against already established or designated areas of special governance arrangements (b).

Note: All maps were developed by Natalia Boulad

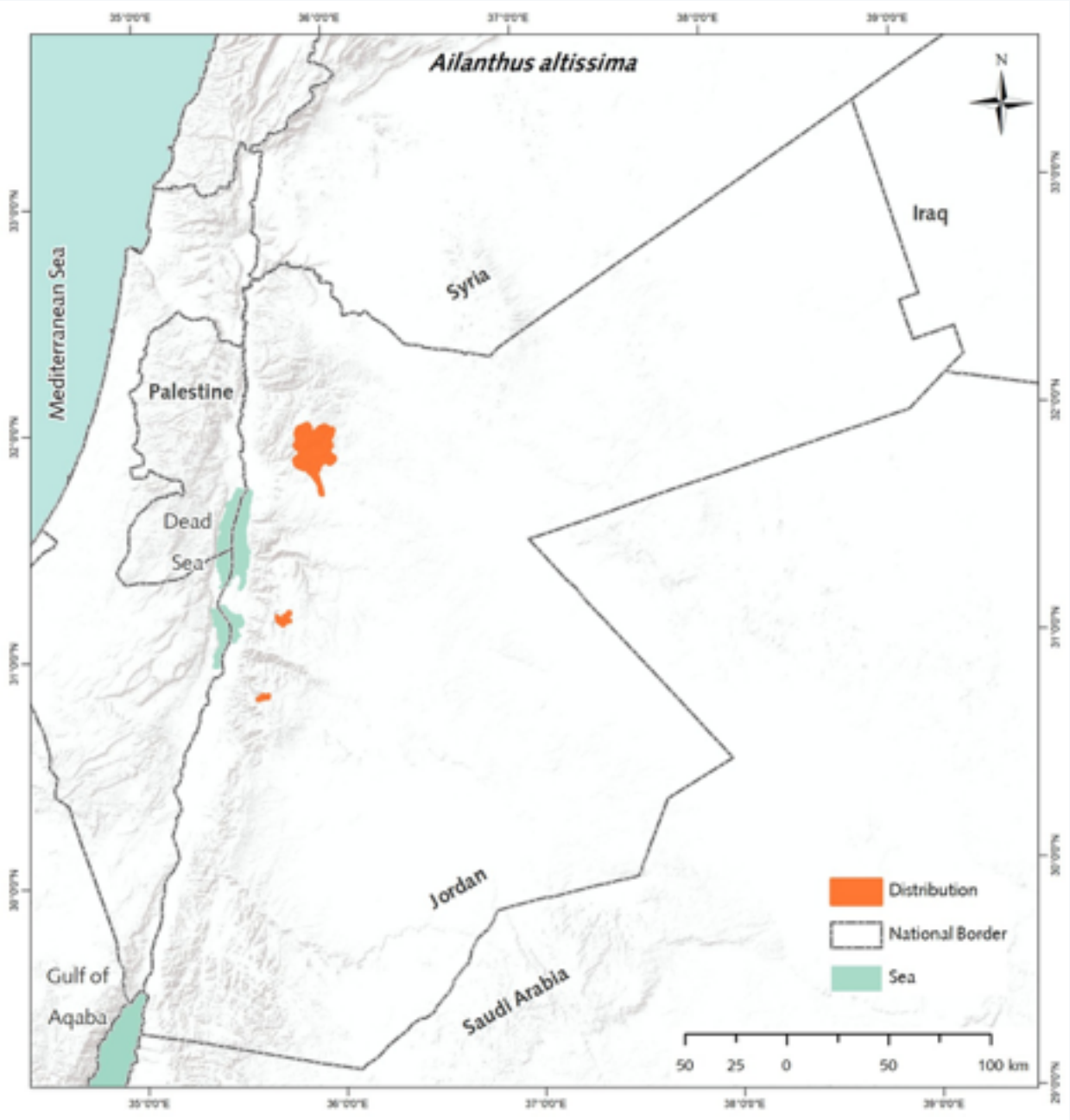
Map. 1a


Prosopis juliflora
Mediterranean Sea
Palestine
Syria
Iraq
Dead
Sea
Jordan
Saudi Arabia
Gulf of
Aqaba
N
Distribution
Sea
National Border
50 25 0 50 100 km

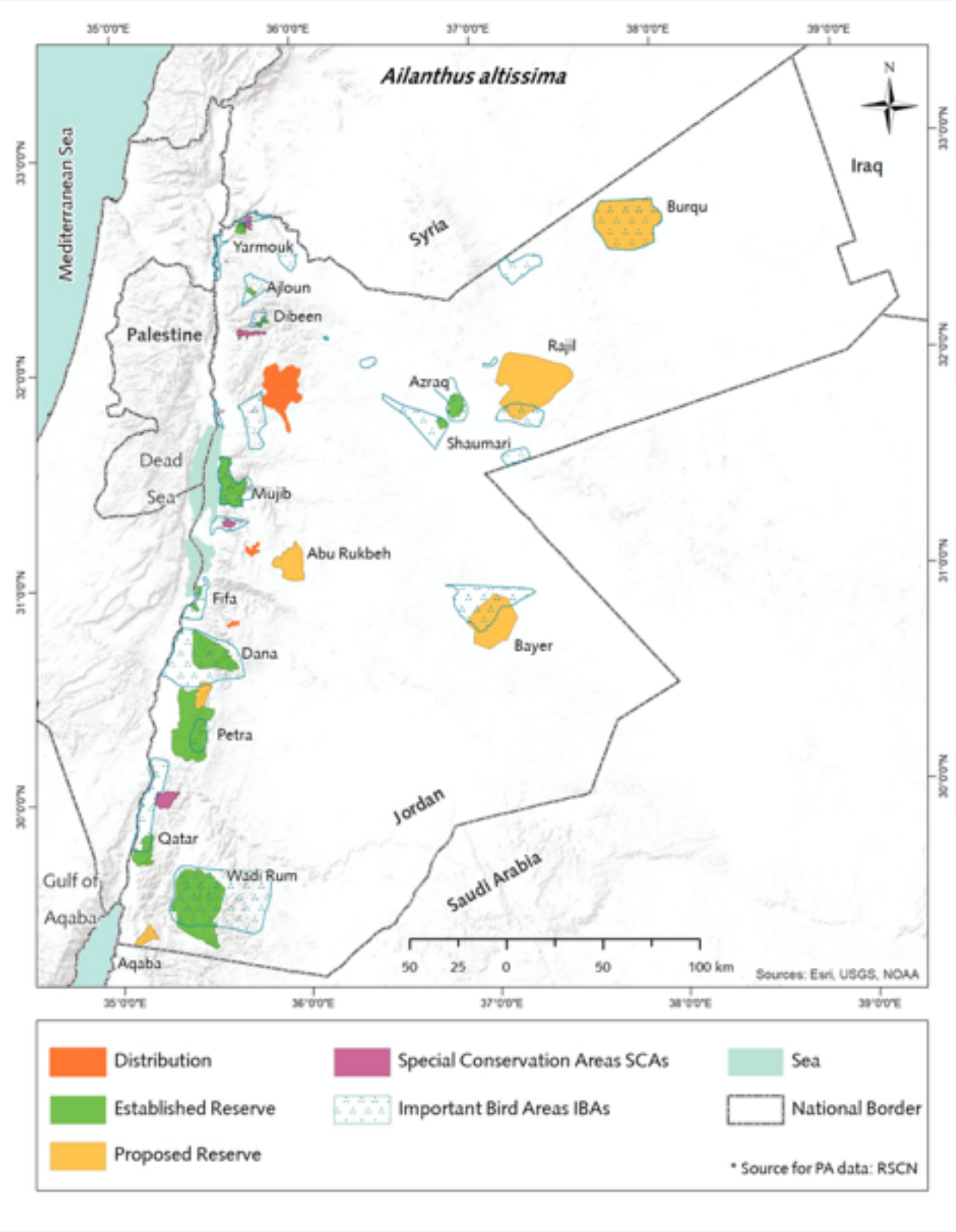
Map. 1b


Prosopis juliflora
Mediterranean Sea
Palestine
Syria
Iraq
Jordan
Saudi Arabia
Dead Sea
Gulf of Aqaba
Yamouk
Ajloun
Dibeen
Mujib
Abu Rukbeh
Fifa
Dana
Petra
Qatar
Wadi Rum
Aqaba
Burqu
Rajil
Azraq
Shaumari
Bayer
N
50 25 0 50 100 km
Sources: Esri, USGS, NOAA
Distribution
Established Reserve
Proposed Reserve
Special Conservation Areas SCAs
Important Bird Areas IBAs
Sea
National Border
* Source for PA data: RSCN

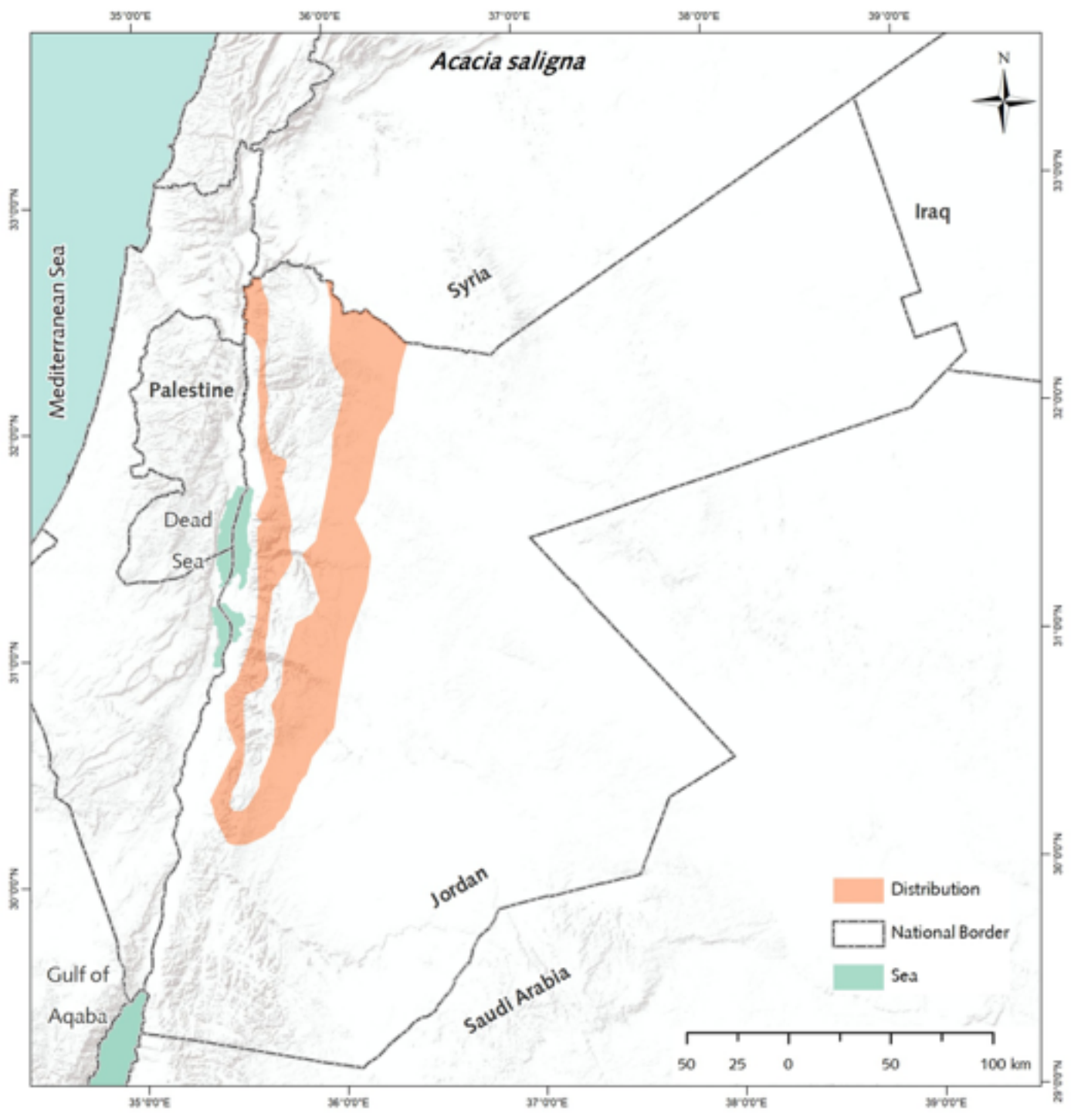
Map. 2a


Ailanthus altissima
N
Mediterranean Sea
Syria
Iraq
Palestine
Dead
Sea
Jordan
Gulf of
Aqaba
Saudi Arabia
Distribution
National Border
Sea
50 25 0 50 100 km

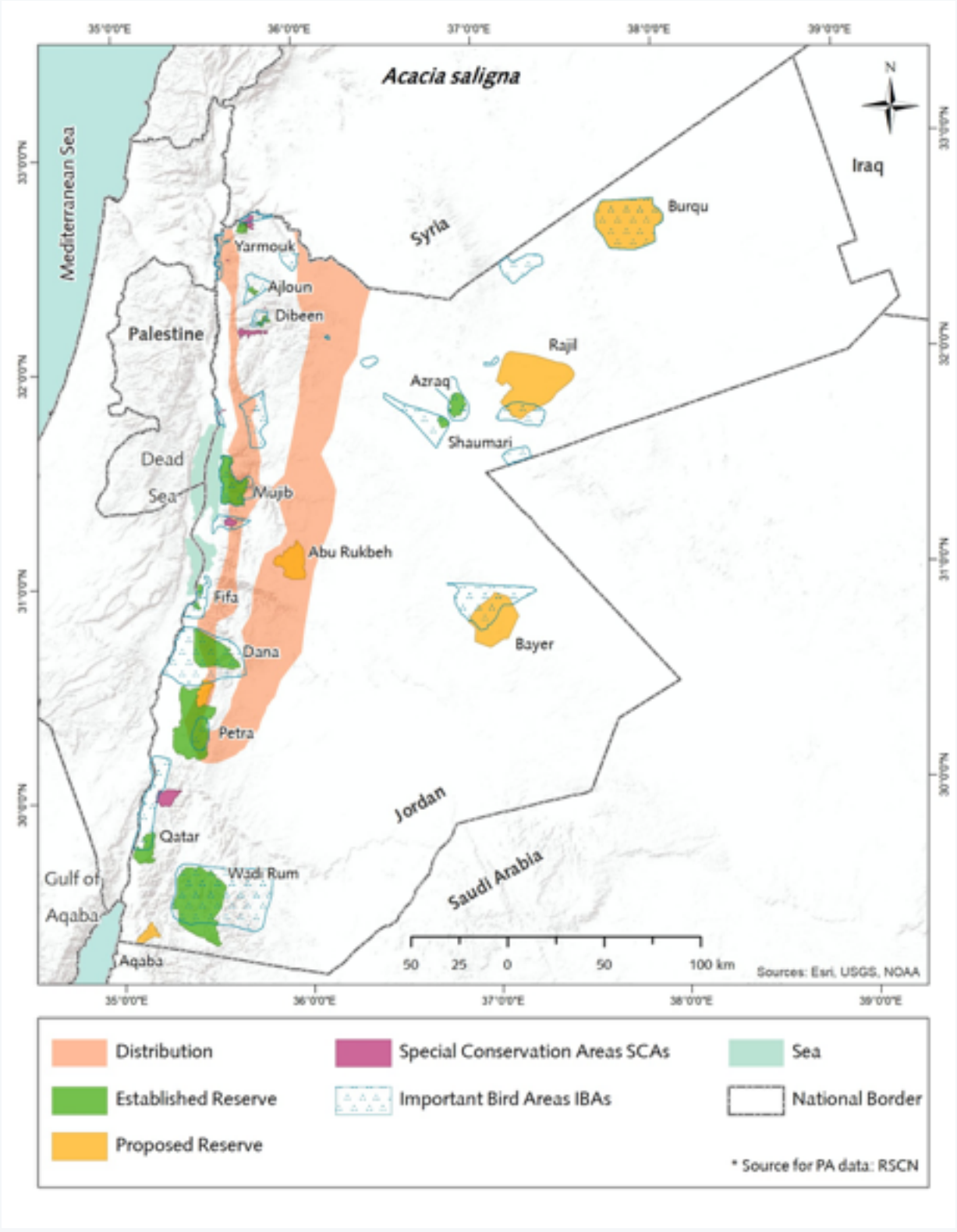
Map. 2b


Ailanthus altissima
Mediterranean Sea
Palestine
Syria
Iraq
Jordan
Saudi Arabia
Gulf of Aqaba
Aqaba
Yarmouk
Ajloun
Dibeen
Burqu
Rajil
Azraq
Shaumari
Dead Sea
Mujib
Abu Rukbeh
Fifa
Dana
Petra
Bayer
Qatar
Wadi Rum
N
50 25 0 50 100 km
Sources: Esri, USGS, NOAA
Distribution
Established Reserve
Proposed Reserve
Special Conservation Areas SCAs
Important Bird Areas IBAs
Sea
National Border
* Source for PA data: RSCN

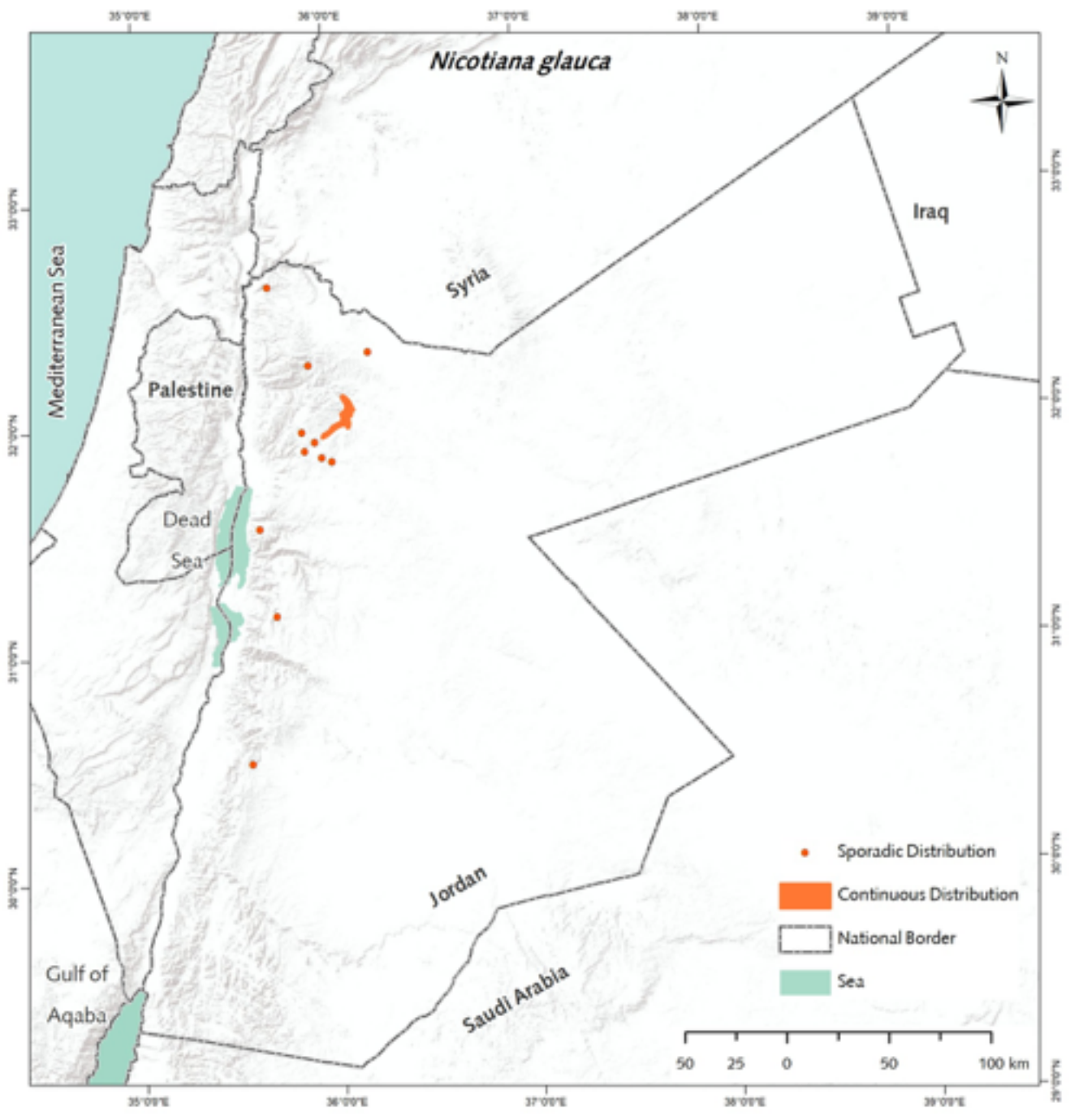
Map. 3a


Acacia saligna
N
Mediterranean Sea
Palestine
Syria
Iraq
Dead
Sea
Jordan
Gulf of
Aqaba
Saudi Arabia
Distribution
National Border
Sea
50 25 0 50 100 km

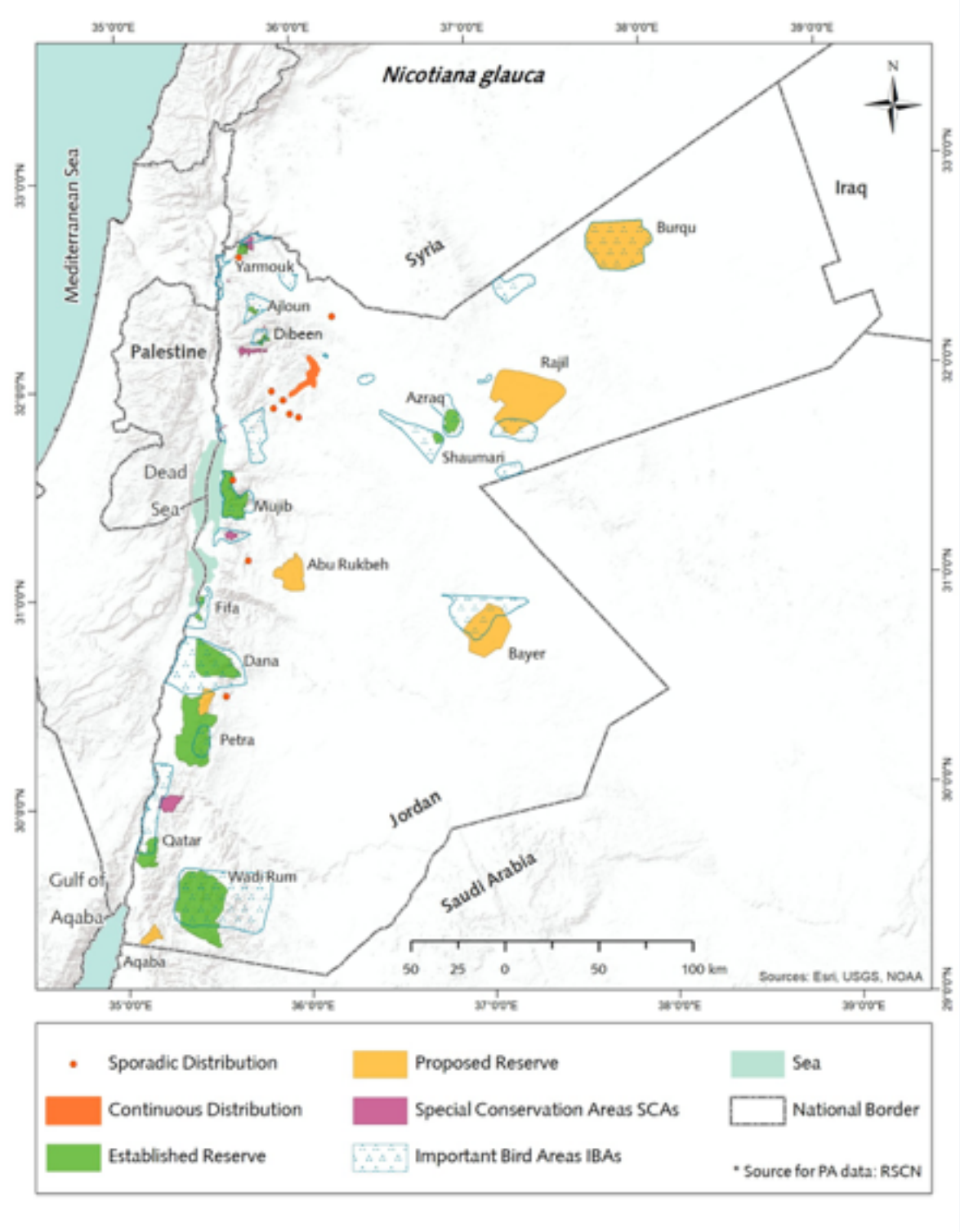
Map. 3b


Acacia saligna
Mediterranean Sea
Palestine
Syria
Iraq
Jordan
Saudi Arabia
Gulf of Aqaba
Dead Sea
Yarmouk
Ajloun
Dibeen
Burqu
Rajil
Azraq
Shaumari
Mujib
Abu Rukbeh
Fifa
Dana
Bayer
Petra
Qatar
Wadi Rum
Aqaba
N
50 25 0 50 100 km
Sources: Esri, USGS, NOAA
Distribution
Established Reserve
Proposed Reserve
Special Conservation Areas SCAs
Important Bird Areas IBAs
Sea
National Border
* Source for PA data: RSCN

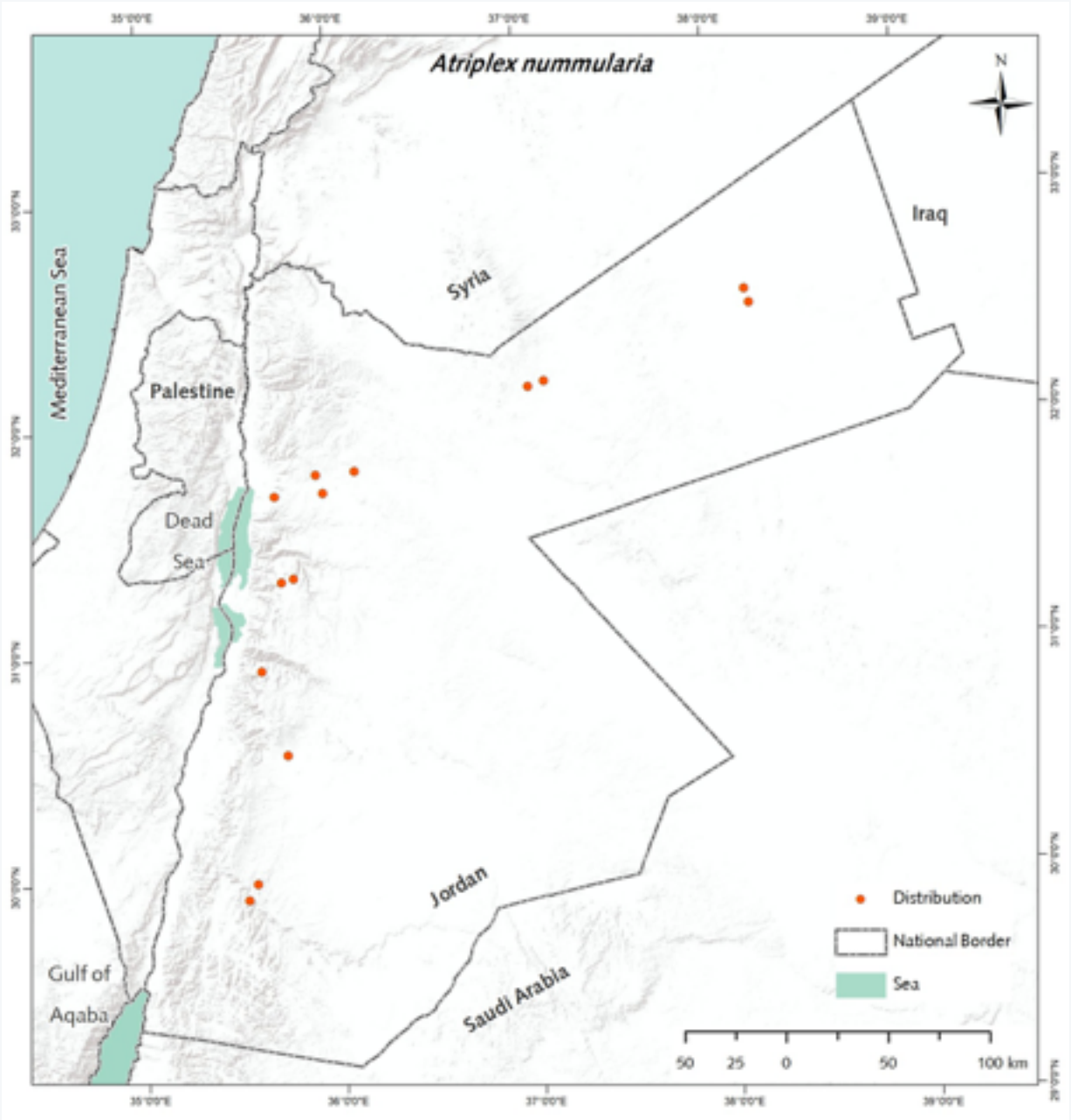
Map. 4a


Nicotiana glauca
N
Iraq
Syria
Mediterranean Sea
Palestine
Dead
Sea
Jordan
Gulf of
Aqaba
Saudi Arabia
Sporadic Distribution
Continuous Distribution
National Border
Sea
50 25 0 50 100 km

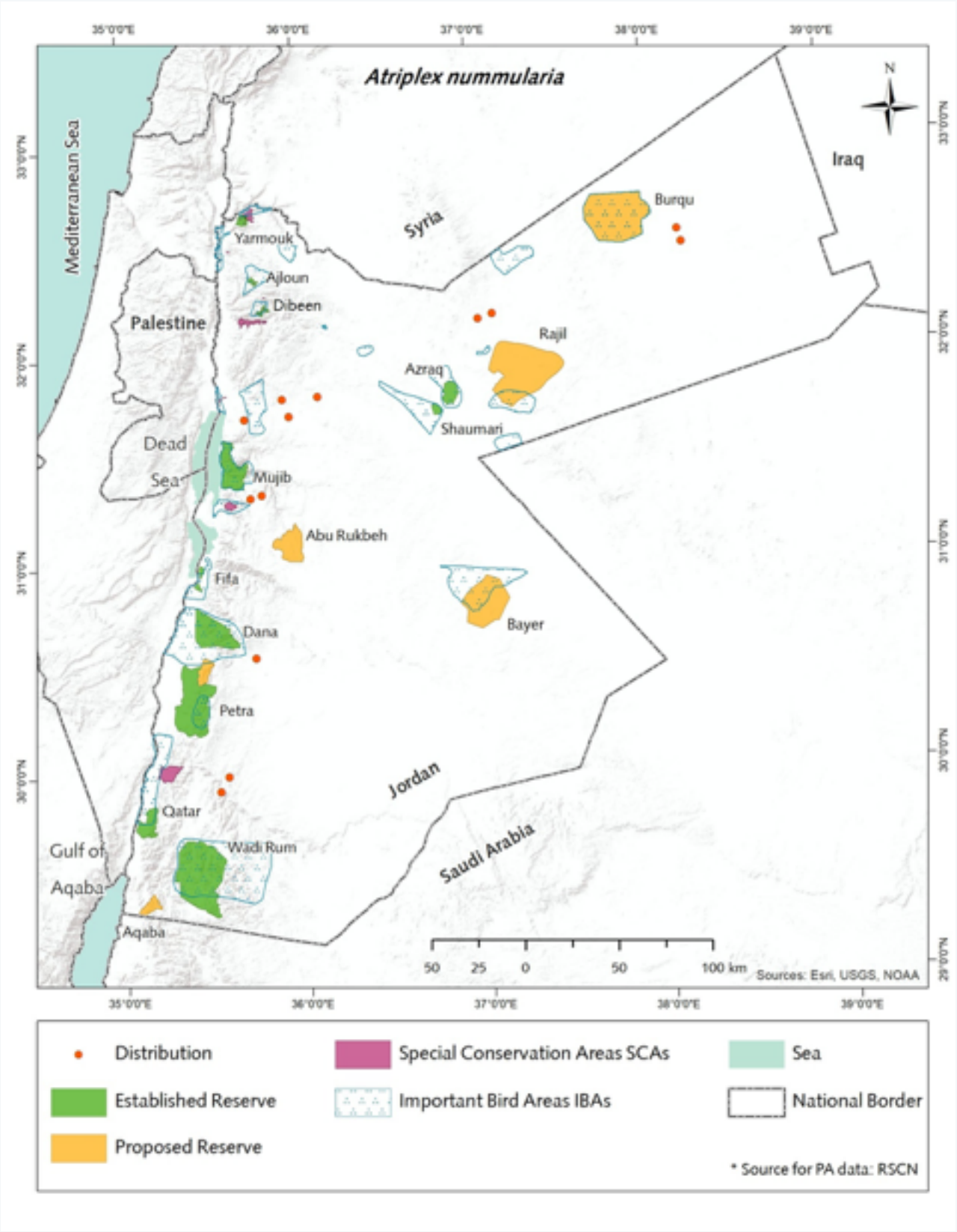
Map.4b


Nicotiana glauca
Mediterranean Sea
Palestine
Syria
Iraq
Jordan
Saudi Arabia
Gulf of Aqaba
Aqaba
Yarmouk
Ajloun
Dibeen
Burqu
Rajil
Azraq
Shaumari
Dead Sea
Mujib
Abu Rukbeh
Fifa
Dana
Bayer
Petra
Qatar
Wadi Rum
50 25 0 50 100 km
Sources: Esri, USGS, NOAA
Sporadic Distribution
Continuous Distribution
Established Reserve
Proposed Reserve
Special Conservation Areas SCAs
Important Bird Areas IBAs
Sea
National Border
* Source for PA data: RSCN

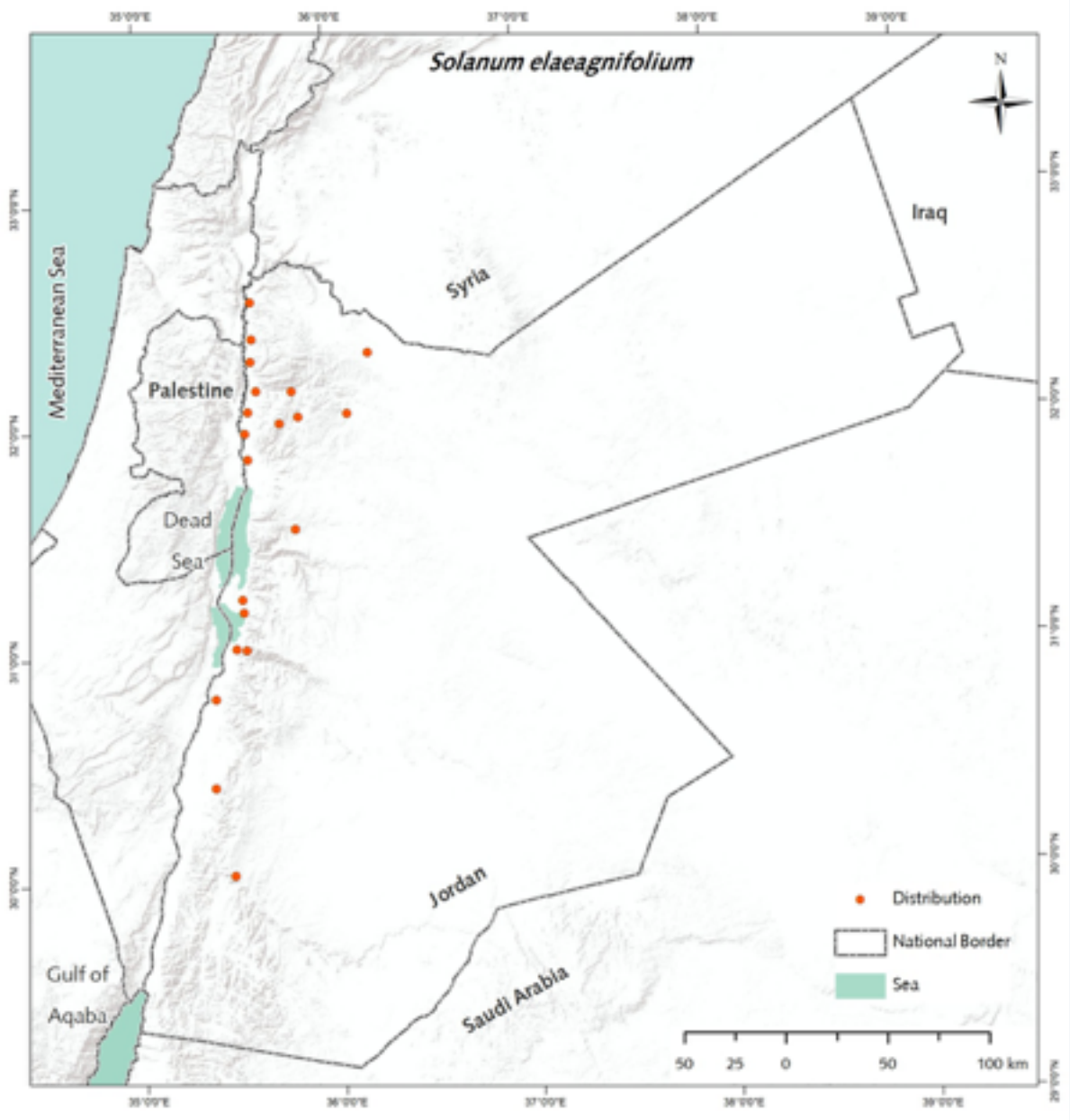
Map. 5a


Atriplex nummularia
N
Iraq
Syria
Mediterranean Sea
Palestine
Dead
Sea
Jordan
Gulf of
Aqaba
Saudi Arabia
Distribution
National Border
Sea
50 25 0 50 100 km

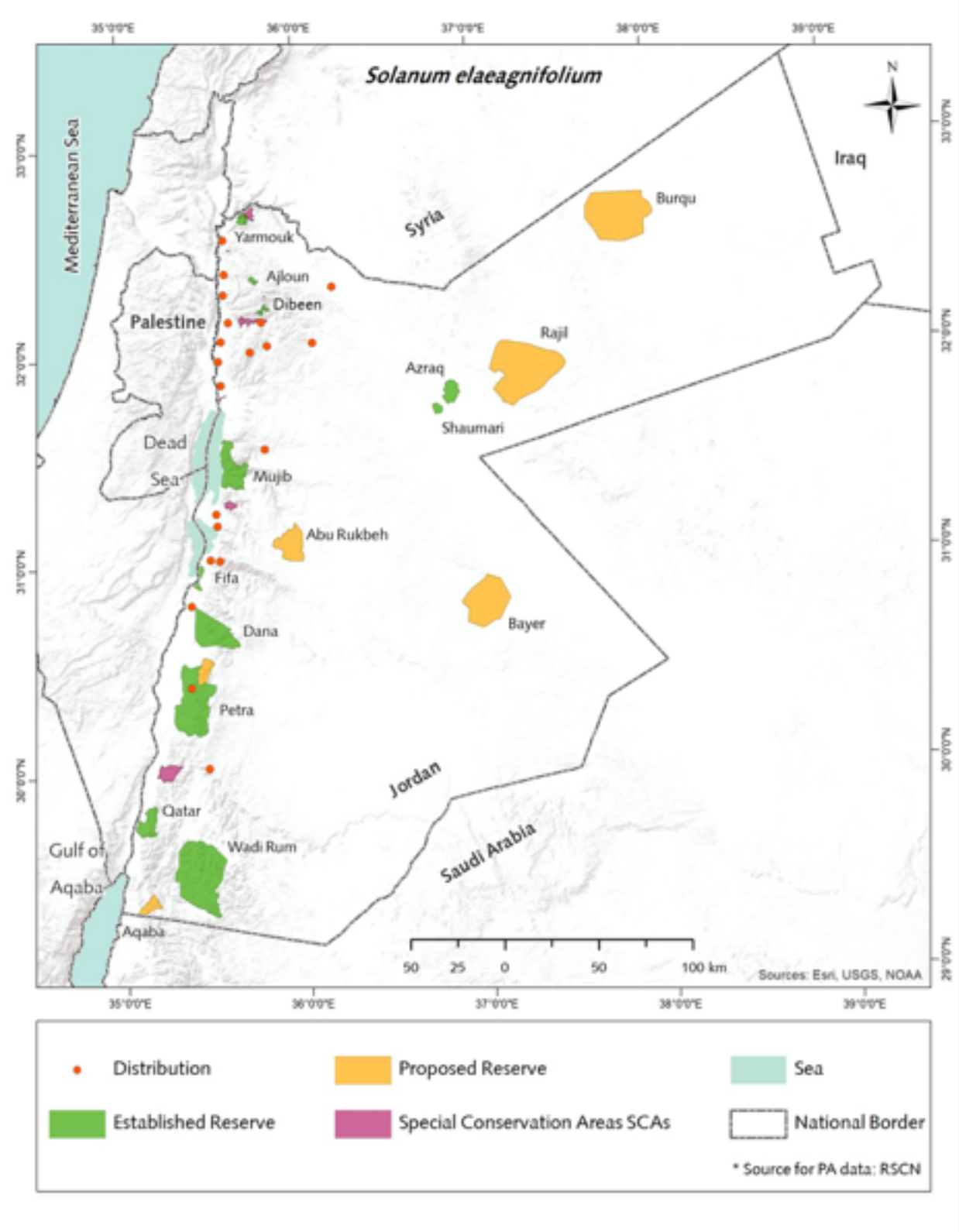
Map. 5b


Atriplex nummularia
Mediterranean Sea
Syria
Iraq
Palestine
Jordan
Saudi Arabia
Dead Sea
Gulf of Aqaba
Yarmouk
Ajloun
Dibeen
Burqu
Rajil
Azraq
Shaumari
Mujib
Abu Rukbeh
Fifa
Bayer
Dana
Petra
Qatar
Wadi Rum
Aqaba
N
50 25 0 50 100 km
Sources: Esri, USGS, NOAA
Distribution
Established Reserve
Proposed Reserve
Special Conservation Areas SCAs
Important Bird Areas IBAs
Sea
National Border
* Source for PA data: RSCN

Map. 6a


Solanum elaeagnifolium
N
Mediterranean Sea
Palestine
Syria
Iraq
Dead
Sea
Jordan
Saudi Arabia
Gulf of
Aqaba
Distribution
National Border
Sea
50 25 0 50 100 km

Map. 6b


Solanum elaeagnifolium
Mediterranean Sea
Palestine
Syria
Iraq
Jordan
Saudi Arabia
Dead Sea
Gulf of Aqaba
Aqaba
Yarmouk
Ajloun
Dibeen
Burqu
Rajil
Azraq
Shaumari
Mujib
Abu Rukbeh
Fifa
Dana
Bayer
Petra
Qatar
Wadi Rum
N
50 25 0 50 100 km
Sources: Esri, USGS, NOAA
Distribution
Proposed Reserve
Sea
Established Reserve
Special Conservation Areas SCAs
National Border
* Source for PA data: RSCN