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VKM Report 2025: 07

Assessment of the risks of negative impacts on biodiversity in Norway from import and keeping of the Turkestan cockroach (*Periplaneta lateralis*)

Lawrence R. Kirkendall, Daniel Flø, Martin Malmstrøm, Anders Nielsen, Paul R. Berg, Anders Bryn, Kjetil Hindar, Johanna Järnegren, Kyrre Kausrud, Erlend Nilsen, Brett K. Sandercock, Eva B. Thorstad and Gaute Velle

Scientific Opinion of the Panel on Biodiversity of the Norwegian Scientific Committee for Food and Environment

Short Abstract: VKM has assessed the potential risk to Norwegian biodiversity associated with the import of the Turkestan cockroach, *Periplaneta lateralis*, as live food for hobby animals. Populations of the cockroach are nearly always found in or near buildings, and non-native populations have never been observed in natural environments. No previous observations of *P. lateralis* have been reported for Norway and it is very unlikely the species will be able to establish and spread into Norwegian nature due to the low winter temperatures and short summers. Furthermore, VKM find that there is low risk associated with the potential effects on biodiversity, if it against all odds, were to establish in Norway. Therefore, VKM concludes that there is low risk associated with import and keeping of *P. lateralis* in relation to its potential negative effect on Norwegian biodiversity.

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Preparation of the opinion

The Norwegian Scientific Committee for Food and Environment (Vitenskapskomiteen for mat og miljø, VKM) appointed a project group to draft the opinion. The project group consisted of two VKM members and two VKM staff members. Two referees commented on and reviewed the draft opinion. The Committee, by the Panel on Biodiversity, assessed and approved the final opinion.

Authors of the opinion

The authors have contributed to the opinion in a way that fulfils the authorship principles of VKM (VKM, 2023). The principles reflect the collaborative nature of the work, and the authors have contributed as members of the project group and/or the VKM Panel on Biodiversity.

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Acknowledgement

VKM would like to thank the referees Bjørn Arild Hatteland (NIBIO) and Roberto Battiston (Museo di Archeologia e Scienze Naturali "G. Zannato", Montecchio Maggiore, Italy) for their valuable comments through critical review of the draft opinion. VKM emphasises that the referees are not responsible for the content of the final opinion. In accordance with VKM's routines for approval of a risk assessment (VKM, 2024), VKM received comments from the referees before evaluation and approval by the VKM Panel on Biodiversity, and before the opinion was finalised for publication.

Competence of VKM experts

Persons working for VKM, either as appointed members of the Committee or as external experts, do this by virtue of their scientific expertise, not as representatives for their employers or third-party interests. The Civil Services Act instructions on legal competence apply for all work prepared by VKM.

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Summary

The Norwegian Environment Agency asked VKM to evaluate the risks to biodiversity associated with the importation of the Turkestan cockroach – *Periplaneta lateralis* Walker – intended as food for hobby animals.

Background

Of the more than 4500 species of cockroaches worldwide, only 40 species are regularly encountered in homes and other buildings, of which about 20 are problematic due to large populations. Cockroaches are mostly viewed as nuisance pests, as they feed on anything edible to humans and degrade the aesthetics of households. Most species also emit a repulsive odour, may harbour and transmit diseases that affect humans and pets, and can cause allergic reactions, including asthma.

The Turkestan cockroach (*Periplaneta lateralis*) is a peridomestic species currently increasing its range by spreading from city to city through human-mediated transport. The exact native range of *P. lateralis* is uncertain, but is widely considered to be North Africa, the Middle East, Central Asia, and Southern Asia (India and Pakistan). *P. lateralis* is described as a desert- or semi-desert dwelling species that lives in hot, arid regions. Under laboratory conditions, the minimum temperature at which females start laying egg cases (oothecae) is 23–25°C (these take 40 days to hatch), nymphal development at 27 ± 2°C takes approximately 222 days for males and 224 days for females. Laboratory studies have showed that at air temperature of -1°C, cockroaches become inactive and die after 53 h.

Invasive populations have established across Russia and in southern and central European countries, the Philippines, Japan, southern USA, and Mexico. All records from non-native areas are from urban environments, usually from buildings or other man-made structures- with no reports from natural habitats.

The introduction of the species to the USA was most likely associated with transport of military equipment returning from the Middle East. Further expansion of its range in the USA and the recent spread within Europe have apparently been due to transport of commercial goods, though escape from hobbyists is also a possibility.

Methods

VKM established a working group with expertise in invertebrates and risk assessment. The group searched scientific literature for information on the taxonomy, natural history, invasiveness, and ecology of *P. lateralis*. Web pages found through supplemental google searches allowed for a broader understanding of the use of the species among hobbyists.

The assessment utilized the EICAT framework (Environmental Impact Classification for Alien Taxa) to identify potential mechanisms by which the species could harm native biodiversity, should imported specimens survive and populations become established in Norwegian nature. The potential mechanisms were analysed by rating the potential magnitude of impact on biodiversity from minimal to massive. The likelihood of each impact was assessed from very

unlikely to very likely. A combination of magnitude of impact and likelihood resulted in final risk levels from low and medium to possibly high and high. Confidence levels for each assessment were also categorized as low, medium, or high based on expert opinion and the available data and literature.

The working group used Maxent species distribution modelling to determine the potential distribution of *P. lateralis* today and under future climate scenarios until 2040.

Results

The potential hazards evaluated under the EICAT framework included competition and transmission of disease. The condition required for *P. lateralis* to reach a natural ecosystem in Norway relates to individuals escaping from captivity or imports as stowaways in cargo from areas where the species is established. Based on laboratory studies of climate requirements, climate conditions in the species presumed native range and invaded areas, and lack of reports of established populations in natural settings in invaded areas we find it very unlikely that the species will be able to establish in Norwegian nature. This conclusion holds also under future climate change until 2040. We have found no reports of *P. lateralis* having negative effects on native biodiversity in invaded areas, neither from competition nor from transmission of pathogens and parasites.

The risk assessments therefore indicate low risk from both competition and spread of disease.

Uncertainties

Uncertainties in the risk assessment include a lack of data on the species distribution in the wild. The male *P. lateralis* closely resembles the congeneric species *P. americana*, and its presence might have been overlooked, thereby hiding its distribution. The identification of the species is, however, not difficult, at least for adult individuals, and does not require expert knowledge as good identification keys are available.

Conclusion

VKM finds it very unlikely that *P. lateralis* will be able to establish in Norwegian nature. The assessment is based on the climate conditions in the assumed native range of the species and the areas where it has become invasive. The conclusion holds also under future climate change until 2040.

VKM concludes that there is a low risk for *P. lateralis* negatively affecting biodiversity in Norway through competition and transmission of pathogens or parasites. The assessments were ranked with medium confidence for competition and low confidence for transmission of disease-causing organisms. The reduced confidence is based on the limited studies available on relevant aspects of the species' biology, in particular its climate tolerance in natural settings and pathogen and parasite loads.

Mitigating measures

To reduce the risk of *P. lateralis* entering Norwegian nature from intentional import, the main mitigating measure is to provide information on the safe handling and disposal of dead or sick individuals, ensuring that importers and hobbyists manage them responsively.

Data gaps

The main data gaps affecting the risk assessment, both regarding the likelihood and magnitude of impact, relates to limited information on the specific temperature and environmental conditions required for the survival and establishment, and lack of information on potential parasite and pathogen loads in imported animals and their effectiveness as parasite hosts or vectors of disease.

Sammendrag på norsk

Miljødirektoratet ba VKM om å vurdere risikoen for biologisk mangfold forbundet med import av turkestansk kakerlakk – *Periplaneta lateralis* Walker – til bruk som mat for hobbydyr.

Bakgrunn

Av de mer enn 4500 kakerlakkartene i verden, er det bare 40 som regelmessig finnes i hus, og av disse er det bare rundt 20 som finnes i store bestander. Kakerlakker ansees som regel som plagsomme skadedyr, da de fleste artene produserer en frastøtende lukt, de spiser også alt som er spiselig for mennesker og kakerlakker i husholdningen oppfattes som lite tiltalende. De kan også bære og overføre sykdommer som kan smitte mennesker og kjæledyr, og kan forårsake allergiske reaksjoner, inkludert astma.

Det eksakte opprinnelsesområdet til *P. lateralis* er noe uklart, men det anses å være Nord-Afrika, Midtøsten, Sentral-Asia og Sør-Asia (India og Pakistan). Innvasive bestander har etablert seg i flere land rundt om i verden, inkludert Russland, flere sørlige og sentraleuropeiske land, Filippinene, Japan, sørlige USA og Mexico. *P. lateralis* beskrives som en ørken- eller semi-ørkenlevende art med naturlig utbredelse i varme, tørre områder. I laboratorieforsøk er det påvist at minimumstemperaturen for når hunnene begynner å legge oothecae (eggkapseler) er 23–25°C, inkubasjonstiden for oothecae er 40 dager og larveutvikling ved rundt 27°C tar omtrent 222 dager for hanner og 224 dager for hunner. Ved lufttemperatur på –1°C går kakerlakkene i dvale og dør etter 53 timer.

Alle registreringene av artens spredning til nye områder er gjort i bystrøk, vanligvis i bygninger eller andre menneskeskapte steder. Vi har ikke funnet studier som viser at arten har etablert seg i naturen.

Metoder

VKM etablerte en arbeidsgruppe med ekspertise innen virvelløse dyr og risikovurdering. Gruppen søkte i vitenskapelig litteratur etter informasjon om taksonomi, naturhistorie, invaderingspotensial og økologien til *P. lateralis*. Nettsider funnet gjennom supplerende Google-søk ga en bredere forståelse av bruken av arten blant hobbyister.

Vurderingen benyttet EICAT-rammeverket (Environmental Impact Classification for Alien Taxa) for å identifisere mulige mekanismer hvor arten kan skade det biologiske mangfoldet i Norge, dersom importerte eksemplarer skulle etablere seg i norsk natur. Mekanismene som ble identifisert inkluderer konkurranse og sykdomsoverføring (spredning av parasitter og sykdom). De to mekanismene ble analysert ved å vurdere den mulige påvirkningen på biologisk mangfold fra minimal til massiv. Sannsynligheten for hver påvirkning ble vurdert fra svært usannsynlig til svært sannsynlig. En kombinasjon av påvirkningens effekt og sannsynlighet resulterte i endelige risikonivåer som varierte fra lav og middels, til muligens høy og høy. Graden av sikkerhet knyttet til hver vurdering ble kategorisert som lav, middels eller høy basert på en ekspertvurdering.

Arbeidsgruppen brukte Maxent utbredelsesmodellering for å bestemme den mulige utbredelsen av *P. lateralis* i dag og under fremtidige (frem til 2040) klimascenarier.

Resultater

De mulige mekanismene vurdert under EICAT-rammeverket inkluderer konkurranse og sykdomsoverføring. Betingelsen for at *P. lateralis* skal nå et naturlig økosystem i Norge, er at individer rømmer fra fangenskap eller importeres som blindpassasjerer i last fra områder hvor arten er etablert. Basert på laboratoriestudier av artens klimakrav, klimaforhold i artens antatte naturlige utbredelsesområde og områder den har invadert, samt mangel på observasjoner av populasjoner i naturen i områder den har invadert gjør at vi anser det som svært usannsynlig at arten vil etablere seg i norsk natur. Denne konklusjonen gjelder også under fremtidige klimaendring-scenarier. VI har ikke funnet studier som viser negative effekter på lokalt biomangfold fra *P. lateralis* i områder den har invadert, hverken fra konkurranse eller fra overføring av sykdommer og parasitter.

Risikovurderingene indikerer derfor lav risiko både fra konkurranse og spredning av sykdom.

Usikkerheter

Usikkerheter i risikovurderingen inkluderer mangel på data om artens utbredelse i naturlige habitater. Hannen ligner sterkt på *P. americana*, og dens tilstedeværelse kan ha blitt oversett, og dermed skjule dens virkelige utbredelse. Identifisering av voksne individer imidlertid ikke vanskelig og krever ikke ekspertkunnskap, da gode identifikasjonsnøkler er tilgjengelige.

Konklusjon

VKM finner det svært usannsynlig at *P. lateralis* vil kunne etablere seg i norsk natur. Dette er basert på klimaforholdene i dens opprinnelsesområde og områdene hvor den har blitt invasiv. Denne konklusjonen gjelder også under fremtidige klimaendringer (frem til 2040).

VKM konkluderer med at det er lav risiko for at *P. lateralis* kan ha negativ påvirkning på biologisk mangfold i Norge gjennom EICAT-mekanismene konkurranse og overføring av sykdom og parasitter. Vurderingene kommer med middels grad av sikkerhet for konkurranse, og lav grad av sikkerhet for sykdoms- og parasittoverføring. Den økte usikkerheten er basert på det begrensede antall tilgjengelige studier som beskriver artens biologi, spesielt dens klimatoleranse og sykdoms- og parasittbelastning.

Avbøtende tiltak

For å redusere risikoen for at *P. lateralis* kommer inn i norsk natur som et resultat av aktiv import, vil et effektivt tiltak være å gi informasjon om sikker håndtering av døde og syke individer, slik at de som holder disse dyrene avhender dem på en trygg måte.

Datamangler

De viktigste datamanglene som påvirker risikovurderingen, både når det gjelder sannsynlighet og omfang av påvirkning, er knyttet til begrenset informasjon om de spesifikke temperatur- og miljøforholdene som kreves for artens overlevelse og etablering. Det er også mangel på informasjon om mulige parasitt- og patogenbelastninger i importerte dyr og i hvilken grad de fungerer som smittebærere.

Background as provided by the Norwegian Environment Agency

The Norwegian Environment Agency has received three different applications under the regulation on alien organisms for the introduction of *P. lateralis* as food for hobby animals. When processing the application, the Norwegian Environment Agency must assess whether the organism applied for may pose a risk of adverse effects on biological diversity, cf. regulation on alien organisms § 6.

We lack the necessary knowledge about this species' ability to establish itself in Norway, and what adverse effects on biological diversity the introduction and keeping of this species may entail.

The assessment of establishment ability and possible risk of adverse effects on biological diversity will form part of the knowledge base the Norwegian Environment Agency uses in its evaluation of whether the species should be allowed to be introduced, and possibly in the assessment of whether the species should be prohibited or exempted from the requirement for a permit under the regulation on alien organisms.

Terms of reference as provided by the Norwegian Environment Agency

The Norwegian Environment Agency requests VKM to:

1. Assess the likelihood of establishment today or in the future given that *P. lateralis* is introduced. A separate assessment of the likelihood of establishment (including a description of uncertainty) should be conducted.

   An assessment of how future climate changes may affect the likelihood of establishment should be included. The assessments should be made from a climate change perspective 10 years into the future and further in a long-term climate perspective.

2. Assess the risk of adverse effects on biological diversity in Norway from the introduction and keeping of P. lateralis, including a description of uncertainty.

   An assessment of how future climate changes may affect the risk of adverse effects should be included. The assessments should be made from a climate change perspective 10 years into the future and further in a long-term climate perspective.

3. Identify and describe possible risk-reducing measures, as well as assess the effectiveness of these measures.

1 Introduction / Background

1.1 Invasive cockroach species

There are over 4500 species of cockroaches worldwide, but only about 40 species are regularly encountered in houses, and of these about 20 are problematic due to large populations (Tang et al., 2019; Li et al., 2025). Four of these species are widespread: the Australian cockroach, *Periplaneta australasiae* Fabricius); the brown cockroach, *P. brunnea* Burmeister; the smokybrown cockroach, *P. fuliginosa* Serville; and the brown-banded cockroach, *Supella longipalpa* (Fabricius). Three species have a global distribution: the American cockroach, *P. americana* (L.); the Oriental cockroach, *Blatta orientalis* L.; and the German cockroach, *Blattella germanica* (L.) (Tang et al., 2019). In Europe, about 130 species are present but no more than 10% of them are pests, and in very few cases do pest species produce large populations[1]. The origin and routes of spread of invasive cockroach species are in many cases unclear. For example, the German cockroach has never been observed in natural habitats, and its origin can therefore not be determined. See Tang et al. (2019) for a review of current knowledge on the most widespread species.

1.2 Problems related to invasive cockroaches

Cockroaches are mostly viewed as nuisance pests, as most species emit a repulsive odour, feed on anything edible to humans, and degrade the aesthetics of households (Peterson & Shardut, 1999). In addition, cockroaches can harbour and transmit human diseases, such as the yellow fever virus, the bacterial agents of cholera, pneumonia, diphtheria, anthrax, tetanus, tuberculosis and salmonella*,* the protozoan species *Entamoeba,* and *Toxoplasma*, and the fungus *Aspergillus* (Geng et al. 2025).

Cockroaches have been found to be of relevant public health concern as carriers of intestinal parasites (Badri et al. 2024, Abdullah et al. 2022), antimicrobial resistant bacteria (Molewa et al 2022), amplifying host of several variants of *Salmonella* bacteria (Mond & Pietri 2023), and a considerable number of food-related pathogens including enteroviruses and bacterial pathogens, with noroviruses and Shiga toxin-producing *Escherichia coli* (STEC) commonly found in environments where food is prepared (Liu et al. 2024), with a wide range of fungal, viral, bacterial and parasitic disease causing organisms found and potentially transmitted and/or amplified by cockroaches in different parts of the world (for table see Geng et al. 2025). Cockroaches also produce allergens that can cause allergic reactions, including asthma (see Peterson & Shardut, 1999 and references therein).

[1] https://cockroach.speciesfile.org/

1.2.1 Hitchhiking organisms and diseases

Cockroaches can carry many parasites, both in the digestive tract and on their external surface. Al-Badrain et al. (2024) screened 111 male individuals of *Periplaneta americana* and identified 19 parasitic species, including intestinal worms, protozoa, and mites, with an overall infection rate of 96.4%. Pflieger et al. (2018) found that ectoparasitic *Herpomyces* fungi are spread globally by their invasive cockroach hosts through the pet trade industry. They found strong host associations, but the likelihood of these fungi switching to native hosts is unknown. Web pages for hobbyists suggest that cockroaches kept as pets can carry mites[2]; which is usually a sign of bad sanitation or poor nutritional status of the animals. However, the mites seem not to harm the cockroaches and can be easily removed. To what extent these parasites can infest other species, in this case native animals in Norway, is unclear.

1.3 How Turkestan cockroaches could spread

Invasive cockroach species could be introduced into Norway through several pathways, including transport of goods and humans across sea, land, and air, as well as the pet trade industry.

1.3.1 Intended import as food for reptiles and invertebrates

The primary pathway for introduction to Norway of *P. lateralis* is purchase of the cockroaches for use as food for spiders, amphibians, reptiles, and other insectivores. As such, *P. lateralis* is widely used, although a web search on several online stores suggests that other cockroach species seem to be more popular, such as the dubia roach (*Blaptica dubia* Serville) or the Cuban roach/ green banana roach (*Panchlora nivea* (L.)). The Turkestan cockroach is particularly popular because it is easy to keep confined (cannot climb on glass and the females are wingless), reproduces rapidly, and can feed on almost anything organic so that colonies can be maintained on pet food (Kim & Rust, 2013). Being sold as live food for hobby animals is often mentioned as a potential pathway of spread (Kim & Rust, 2013; Davranoglou et al., 2020; Battiston et al., 2022; Petrovskiy et al., 2024).

1.3.2 Unintended import as stowaway

In the USA, Turkestan cockroaches were first collected from military bases, and the species is thought to have been accidentally introduced on multiple occasions via the transport of military equipment and other supplies returning from deployment in central Asia and the middle East (Kim & Rust, 2013). More relevant for Norway, Battiston et al. (2022) emphasized the possible role of shipping of goods among European countries as an explanation for rapid recent spread of *P. lateralis* in Europe. The species could be similarly imported by accident to

[2] https://extension.okstate.edu/fact-sheets/madagascar-hissing-cockroaches-information-and-care.html

Norway, as stowaway in truck cargo, ships, vehicles or luggage originating in countries with established populations of *P. lateralis*.

1.4 Taxonomy of *Periplaneta lateralis*

The Turkestan cockroach (Figure 1) has had a variety of names since it was first described in the mid-19th century, but most alternative names had only short-term use. The correct scientific name is that under which the species was first described in 1868: *Periplaneta lateralis* Walker. Analyses of both molecular and morphological data led Deng et al. (2023) to restore the species to its original genus, *Periplaneta.* The generic classification was supported by subsequent molecular analyses by Luo et al. (2023, 2025) and Li et al. (2025).

Most scientific literature up until 2023 uses either *Shelfordella lateralis* or *Blatta lateralis* for the Turkestan cockroach but one occasionally finds it referred to as *Blatta tartara* (Saussure) or *Shelfordella tartara* Saussure. The transfer back to *Periplaneta* is relatively

recent, and some companies selling these cockroaches as food for insectivorous pets still use the previous names of *Blatta lateralis* or *Shelfordella lateralis*.

Figure 1: Dorsal view of male (left. Photo: James Bailey, CC by NC) and female (right. Wikimedia Commons) *Periplaneta lateralis.*

1.5 Relevant ecological and biological traits of *Periplaneta lateralis*

1.5.1 Distribution and habitats

The exact native range of *P. lateralis* is uncertain, but is widely considered to be North Africa, the Middle East, Central Asia, and Southern Asia (India and Pakistan). Davranoglou et al. (2020) reported established populations in Cyprus and Turkey as being invasive. The Turkestan cockroach has also established breeding populations in the southern USA (Petersen & Cobb, 2009; Kim & Rust, 2013), Mexico (de Luna et al., 2021, 2025), Spain (Pradera & Carcereny, 2018; Pradera et al., 2023), central and eastern Europe, Sardinia and mainland Italy (Battiston et al., 2022);, Malta (Bohn & Sciberras, 2021), the Philippines (Agua et al., 2023), Russia (Petrovskiy et al., 2024), and Japan (Komatsu et al., 2023). All reported findings of live specimens in the GBIF database are shown in Figure 2. Where specified, all of the aforementioned records are from urban environments, usually from buildings or other man-made structures (see Table 1), and none of those studies reported sampling from free-living populations in natural habitats.

Figure 2: Map showing occurrence data of *P. lateralis* as recorded in the GBIF database on July 29th 2025 (https://www.gbif.org/species/1999789). Darker colours indicate higher densities.

Little has been published about the natural habitats of *P. lateralis* in its native range. Studies on *P. lateralis* refer to habitat requirements in general terms, as being a desert- or semi-desert dwelling species that lives in hot, arid regions (e.g. Olson, 1985; Kim & Rust, 2013). No information on natural populations is available, expect one mention of all stages being found in a bat cave in Turkmenistan (Roth & Willis, 1960: 18). We found no reports of introduced populations being established in natural habitats. In Cyprus, for example, no specimens were found in semi-disturbed or natural habitats adjacent to human settlements (Davranoglou et al., 2020).

Nearly all scientific papers or websites with information on this species are written in the context of its being a non-native species. Generally, the Turkestan cockroach is described as being found near—but not in— human habitations (Table 1). As an established non-native species, *P. lateralis* is referred to as synanthropic or peridomestic, which is a species in a close

association with human-modified habitats, such as gardens, sewers, manure heaps, and landfills (Roth & Willis, 1960; Kim & Rust, 2013; Abbasi et al., 2019; Davranoglou et al., 2020). The species is only rarely found in human homes (Roth & Willis, 1960; Kim & Rust, 2013; Davranoglou et al., 2020), though it has been frequently trapped in school buildings in Southern California (Taravati, 2022). Memora et al. (2017) reported that, in Lahore, Pakistan, the species was common in bedrooms and kitchens of homes among other sites. In Arizona, the species was found in "urban settings" but there were no reports of indoor breeding populations (Olson, 1985).

Table 1. Specific habitats where Turkestan cockroaches have been observed.

Country or Region	Sites	Reference
Uzbekistan	Piles of dry manure used in gardens	Artyukhina & Sukhova, 1972
Central Asia	Houses with clay floors	Bei-Benko, 1950
Bagdad, Iraq	Sewers and manholes near hospitals	Kassai & Mohsen, 1994
California, USA	Warehouses, steam tunnels	Cochran, 1982
California, USA	Most commonly, in-ground boxes*; various school building rooms; earthquake fissures	Gulmahamad, 2004
California, USA	Garages, compost piles	Rios & Honda, 2013
California, USA	School classrooms, offices, and storage rooms	Taravati, 2022
Arizona, USA	Matted ground cover, debris in lawns	Olson, 1985
Desert southwest, USA	In-ground boxes, hollow block walls, under broken pavement	Kim & Rust, 2013
Georgia, USA	Inside and outside a brick building	Petersen & Cobb, 2009
Barcelona, Spain	City park	Pradera & Carcereny, 2018
Valencia, Spain	Elevator shaft of a logistics platform and surrounding sewers	Pradera et al., 2023
Rome, Italy	City centre: near flower bed, and in a small park	Battiston et al., 2022
Malta	"…numerous locations associated with pet trade [and] …caves or cave-like constructions outside of settlements."	Bohn & Sciberras, 2021
Fukuoka Prefecture, Kanagawa Prefecture, Japan	Logistics warehouse, food warehouse	Komatsu et al., 2022
Russia, northern regions	Urban community infrastructure with stable environments	Petrovskiy et al., 2024
Russia, Sochi	Within city borders but outside of infrastructure	Petrovskiy et al., 2024

*In-ground boxes: water meters; electric, sewer, gas shut-off valves; irrigation control valves; and similar

1.5.2 Temperature and humidity

Periplaneta lateralis is described as a desert- or semi-desert dwelling species that lives in hot, arid regions (see section 1.5.1). The optimal temperature for development in arid environments and under artificial conditions was reported as 30 and 27°C, respectively (Kapanadze, 1971; Dremova and Alesho, 2011). At such temperatures, the ootheca

development takes approximately 40 days (Kim & Rust, 2013). The minimum temperature at which females start laying oothecae (egg cases) is 23–25°C. Additionally, the nymphal development at 27 ± 2°C takes an average of 222 days for males and 224 days for females (Kim & Rust, 2013). In laboratory studies the Turkestan cockroaches become inactive and die after 53 h when exposed to air temperature of –1°C (Kapanadze, 1971). However, under natural conditions the cockroaches can escape these low temperatures by sheltering in man-made structures.

Other cockroach species, such as *P. japonica* (Tanaka & Tanaka, 1997) and *Celatoblatta quinquemaculata* (Block et al., 2003) can tolerate supercooling at temperatures below -5°C, but survival rates decrease rapidly with time spent at low temperatures. These two species are, however, adapted to colder climates and the results from Kapanadze (1971) suggest that *P. lateralis* cannot survive freezing conditions for more than three days.

1.5.3 Reproduction and diet

Cockroaches are relatively long-lived species of insects. When raised in the laboratory, the oothecae (containing 16-18 eggs) hatch after 40 days. The five nymphal stages take five to seven months to complete, and adult males and females of *P. lateralis* live for a further seven to thirteen months (Kim & Rust, 2013 and data they cite from Kapanadze, 1971).

Despite a long maturation period, the reproductive rate of *P. lateralis* is relatively high. Turkestan cockroaches develop faster, live much longer, and produce more oothecae than ecologically similar species including Oriental cockroaches. Indeed, *P. lateralis* is the fastest breeding cockroach species that is used as food for insectivorous pets (https://texasinvasives.org/pest_database/detail.php?symbol=32). Under semi-natural outdoor conditions in Cyprus, a captive population kept in an unheated warehouse increased from 30 to 4000 individuals over two years (Davranoglou et al., 2020).

Turkestan cockroaches can feed on a wide variety of non-living organic matter, including human foods, decaying plant matter, garbage, pet food, and other food scraps[3].

1.5.4 Other risk assessments of the same species

The Norwegian Biodiversity Information Centre (NBIC, Artsdatabanken 2023) has not risk assessed *P. lateralis*, but in a horizon-scan for potential door-knocker species they identified three other species within the *Periplaneta* genus. NBIC concluded that the combined score in relation to their establishment potential and the potential for negative impacts, was too low to mandate further risk assessment. The three species, *P. americana* (Endrestøl et al. 2023-1), *P. australasiae* (Endrestøl et al. 2023-2) and *P. brunnea* (Endrestøl et al. 2023-3) have similar life history traits and environmental constraints as *P. lateralis*.

[3] https://www.bigtimepestcontrol.com/learning-center/turkestan-cockroaches

2 Methodology and data

2.1 Risk assessment methodology

For the questions outlined in the Terms of Reference (ToR), hazards were identified and assessed separately. VKM evaluated each potential hazard as a mechanism through which impacts may occur, following four standardized steps: hazard identification, hazard characterisation, likelihood assessment, and risk characterisation, as described below.

2.1.1 Description of possible mechanisms for impact

Each hazard was associated with a mechanism through which it could have an effect. VKM used the EICAT (Environmental Impact Classification for Alien Taxa) classification system (IUCN, 2020) to first identify which impact mechanisms are relevant for the assessed species. The 12 key mechanisms that are considered in the risk assessment are listed in Table 2.

Table 2. Key impact mechanisms through which a non-native organism can lead to harm on native organisms and ecosystems.

#	Impact mechanism	Description
1	Competition	The alien organism competes with native organisms for resources (e.g., food, water, space)
2	Predation	The alien organism preys on native organisms
3	Hybridisation	The alien organism hybridizes with native organisms
4	Transmission of disease	The alien organism transmits diseases to native organisms
5	Parasitism	The alien organism parasitizes native organisms
6	Poisoning/toxicity	The alien organism is toxic, or allergenic by ingestion, inhalation, or contact, or allelopathic to plants
7	Bio-fouling or other direct physical disturbance	The accumulation of individuals of the alien Organism on the surface of a native organism (i.e., bio-fouling), or other direct physical disturbances not involved in a trophic interaction (e.g., trampling, rubbing, etc.)
8	Grazing/herbivory/browsing	Grazing, herbivory or browsing by the alien organism
9	Chemical impact on ecosystem	The alien organism causes changes to the chemical characteristics of the native environment (e.g., pH; nutrient and/or water cycling)
10	Physical impact on ecosystem	The alien organism causes changes to the physical characteristics of the native environment (e.g., disturbance or light regimes)
11	Structural impact on ecosystem	The alien organism causes changes to the habitat structure (e.g., changes in architecture or complexity)
12	Indirect impact through interactions with other species	The alien organism interacts with other native or alien organisms (e.g., through any mechanism, including pollination, seed dispersal, apparent competition, mesopredator release), facilitating indirect deleterious impact

2.1.2 Description of hazard identification

In the hazard identification section, we described the specific hazard, including the mechanisms that the hazard has effect through, and why each hazard is considered in the current assessment. The known effects of the hazard are presented and examples of the impacts from other countries are included, where known.

2.1.3 Description of hazard characterisation

In the hazard characterisation section, the specific potential effects of the hazards in question are evaluated in terms of their nature, intensity, and potential to cause harm under Norwegian conditions. Here, the potential magnitude of the specific hazards is ranked from "Minimal" to "Massive", as described in Table 3. The characterisation assumed that at least one population has been established in Norway.

Table 3. Rating of the potential magnitude of impact on biodiversity in Norway

Rating	Impact descriptors
Minimal	Impact on biodiversity is limited to occasional deaths of individuals. No expected effects on the local-, regional-, or national population size.
Minor	Impact on biodiversity includes limited reductions in local abundance of one or a few species and these effects are temporally and spatially limited. No expected effects on the regional-, or national population size.
Moderate	Impact on biodiversity can result in moderately reduced abundance of one or more species, with potential implications on population viability at a regional level.
Major	Impact on biodiversity may cause severe reductions in the abundance of one or more species, including potential extinction of local or regional populations. Consequences may also affect ecosystem functions and services. The consequences are likely reversible if the assessed species can be successfully eradicated.
Massive	Impact on biodiversity may cause detrimental reductions in the abundance of more than one native species, including extinction of local populations and potentially threaten the survival of the national population. Consequences are likely to affect ecosystem functions and services and are likely irreversible.

2.1.4 Description of likelihood

In the likelihood section, we assess how likely it is that the characterized hazard occurs. Likelihood intervals range from 0-5% "Very unlikely" up to 75-100% "Very likely" (Table 4). In most cases and unless otherwise stated explicitly, the likelihood was based on subjective assessments (also referred to as expert judgement), rather than frequency-based likelihood or specific modelling that estimate the likelihood. The likelihood assumes that at least one population has been established in Norway.

We also present an approximation of the overall risk posed by the species by incorporating the potential impact of the hazard with the greatest magnitude and the likelihood of establishment.

Table 4. Rating of the likelihood of specific impacts in the assessment.

Rating	Likelihood descriptors
Very unlikely	Negative consequences would be expected to occur with a likelihood of 0-5%
Unlikely	Negative consequences would be expected to occur with a likelihood of 5-10%
Moderately likely	Negative consequences would be expected to occur with a likelihood of 10-50%
Likely	Negative consequences would be expected to occur with a likelihood of 50-75%
Very likely	Negative consequences would be expected to occur with a likelihood of 75-100%

2.1.5 Description of risk characterisation

In the risk characterisation section, the risk to biodiversity in Norway, posed by the specific hazard, was characterized as either “Low”, “Medium”, “Possibly high” or “High”. The characterisation was based on the combination of the overall likelihood of the event occurring and then the magnitude of potential impact of a hazard given that an event occurs (Figure 3)**.**

2.1.6 Description of confidence assessments

For each assessment of potential impact (hazard characterisation) and likelihood, and eventually the risk, VKM described the level of confidence with which these assessments were made. Confidence was based on both the level of information available on each subject, the relevance and consistency of that information (Table 5). The basis of the confidence of each assessment is presented graphically in a matrix as illustrated in Figure 4.

Table 5. Qualitative scale used for describing the level of confidence in an assessment.

Rating	Confidence descriptors
Low	Low confidence is often the result of little or poor data, or if the data provided is inconsistent or partly inconsistent. This is often the case when there is limited information on the specific subject, in particular from comparable environmental settings. Subjective expert judgements may be introduced without supporting evidence. There is often also little peer reviewed literature is available and there are limited to no empirical and quantitative data to support the assessment.
Medium	Relevant information on the specific subject is available, but only limited information from comparable environmental settings. Some subjective expert judgements are introduced. Both grey literature and peer reviewed literature are used and there are some empirical and quantitative data to support the assessment.
High	Thigh confidence is appointed to assessments where there is high data quality of ample amounts and these are predominantly consistent. This means that there is extensive information on the specific subject, also from comparable environmental settings. Few or no subjective expert judgements are introduced. Peer-reviewed literature is used primarily and there are empirical and quantitative data to support the assessment.

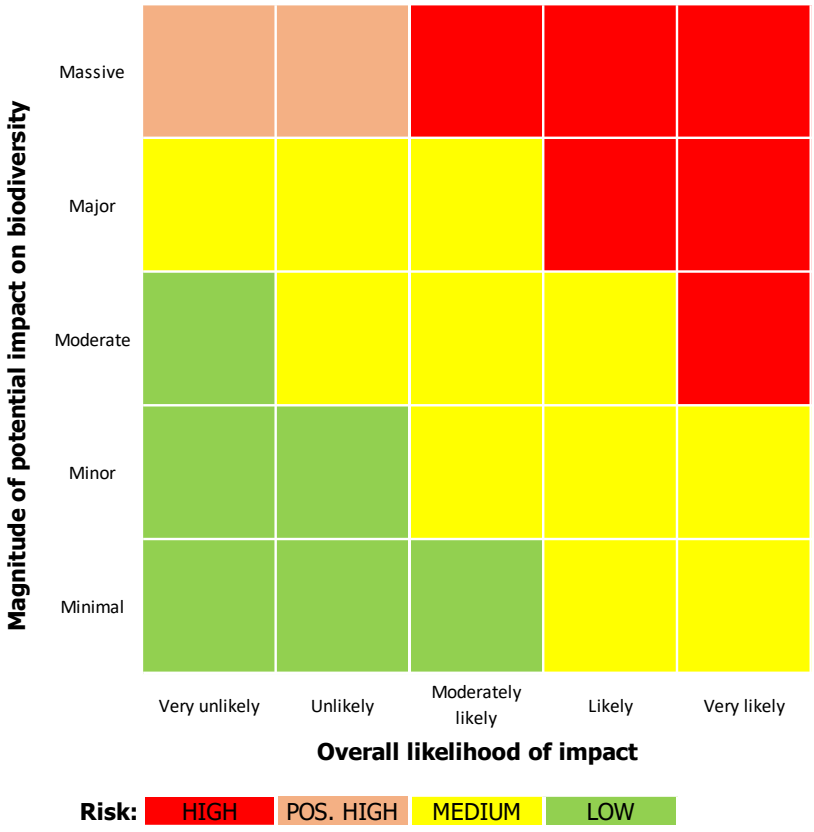

Figure 3: The risk matrix used to graphically illustrate the assessed risks.

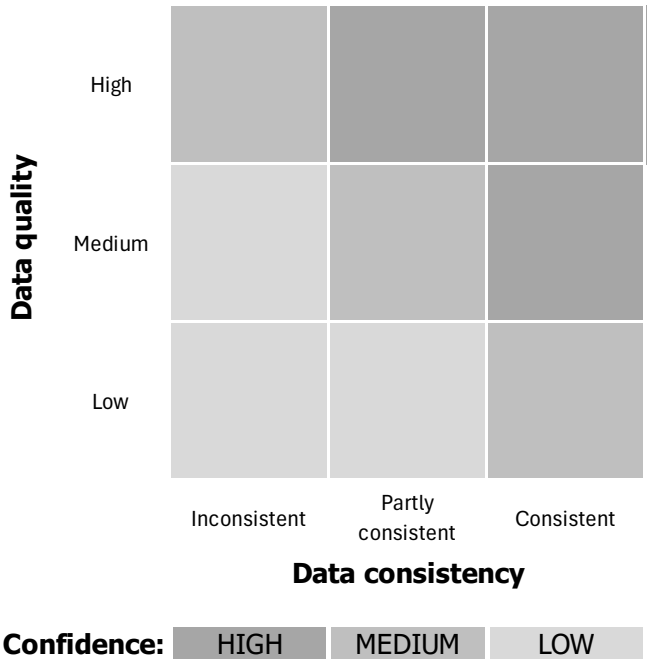

Figure 4: The confidence matrix used to graphically illustrate the confidence of the assessments.

2.2 Literature search and selection

The primary sources of scientific literature were identified using ISI Web of Science and Google Scholar, using the following search terms: *Periplaneta lateralis, Blatta lateralis, Shelfordella lateralis*, and Turkestan cockroach. In some cases, additional references were located by reviewing the citation lists of relevant articles or checking for subsequent citations of key articles.

Searches occasionally led to web pages containing relevant information. Some of these web pages were linked to databases maintained by universities, such as Texas A & M University[4]and University of California[5,6]. The databases provide summaries of ecological knowledge and with references to scientific publications.

2.3 Data and modeling

2.3.1 Data collection and preparation

Occurrence depicting the distribution of *P. lateralis* were obtained from GBIF (The Global Biodiversity Information Facility), iNaturalist, and iDigBio (Integrated Digitized Biocollections). Data points include all available years (1978-2025). After pooling all the available occurrence data points (7697), we preprocessed them using functions of the R library CoordinateCleaner (Zizka et. al. 2019). Standard processing steps included removing records with duplicate coordinates with identical latitude and longitude, as well as records found in country capitals. We also deleted records in the vicinity of biodiversity institutions, non-terrestrial coordinates, invalid latitude and longitude coordinates, zero-zero coordinates, country centroids, and coordinates assigned to the GBIF Headquarters. To avoid known problems of spatial bias in sampling effort, we thinned the occurrence data to one point per raster cell at a resolution of 30 arc sec, which is approximately 1 km. We accepted a total of 6790 unique occurrence points for modelling and used Setseed to ensure reproducibility when selecting random subsets of the dataset. The data used was prepared and processed using R software, R Core Team (2023).

Instead of randomly sampling background points (environment samples) across the landscape, background points were sampled from 200 km polygons around each presence point to get more restricted and representative environmental samples (Phillips 2008). A total of 40,000 samples were drawn, but only 20,887 unique points were used due to duplicated background points, points outside the study area, or points in the ocean.

A total of 19 environmental raster layers were obtained from the WorldClim database (Fick and Hijmans, 2017) at ~1 km spatial resolution for historical climate (1981-2010), and future

[4] https://citybugs.tamu.edu/2024/06/26/the-turkestan-cockroach-an-emerging-pest-in-texas/

[5] https://ucanr.edu/site/urban-and-community-ipm-capital-corridor/turkestan-cockroach

[6] https://ucanr.edu/blog/pests-urban-landscape/article/invasive-spotlight-turkestan-cockroach

climate (2021-2040 Max Planck Institute Earth System Model mpi-esm-1.2, scenario ssp245) which, conservatively, predicts a global temperature increase of 0.9-2.7 °C (Lee et al. 2021). All environmental data layers were cropped, masked, and resampled to a bounded study area (longitude: 180E to 180W, latitude: 60S to 90N), thus removing Antarctica.

2.3.2 Maxent species distribution modeling

A Maxent species distribution model was deployed to determine the potential distribution of *P. lateralis* across geographic space based on the chosen environmental and land use variables. Maxent was run using the library SDMtune (Vignali et al. 2022), over "maxnet", which fits Maxent models using the glmnet package for regularized generalized linear models (Phillips et al. 2017). Also, it reduces computational time and avoids the standard Java implementation. The SDMtune functions for data-driven variable selection and hyperparameter tuning were used to optimize the models.

The first step involved running a standard Maxent model that used all variables (all 50 raster layers described above), a regularisation multiplier of 1, and the feature class combinations linear, quadratic, threshold, and hinge (see Halvorsen et al. 2015 for a more comprehensive description of Maxent). Then, we dropped environmental variables that contributed less than two percent to training the initial model. Data-driven variable selection was then performed on the remaining environmental variables. Afterwards, a grid search was conducted over a selection of hyperparameter values. The final optimized Maxent model was then executed with a regularisation multiplier of 1 (the regularisation multiplier was relaxed from the selected hyperparameter value of 0.5 to reduce model complexity and increase generalisation), and only linear and quadratic relationships were used for the explanatory variables. To evaluate model performance, we conducted five replicate runs using a cross-validation approach (20% for testing and 80% for training).

2.3.3 Model evaluation

The performance of the model was evaluated through the area under the receiver operating characteristic curve (AUC). AUC values range from 0 to 1, with values above 0.5 indicating performance better than random. An AUC value of 0.9 can be considered very good, which means the classifier can accurately distinguish between classes. Our model's average AUC value from five replicate runs was 0.932 - indicating outstanding discriminatory ability (Araujo et al. 2005; Hosmer et al. 2013).

2.3.4 Variable importance analysis

Variable importance was assessed using the percentage contribution and permutation importance metrics provided by SDMtune. Percent contribution represents the relative contribution of each environmental variable to the model, while jackknife permutation (n=5) importance represents the reduction in model performance when each variable is separately removed from the set of variables.

The four most important environmental variables for predicting the distribution of *P. lateralis* were annual mean temperature (Bio 1, 58.2%), annual precipitation (Bio 12, 30.6%),

precipitation of coldest quarter (Bio 19, 6.8%) and precipitation seasonality (Bio 15, 4.4%). These four variables were consistently ranked high across all runs and, based on the optimal range predicted for the species, clearly show that Norway is too cold and wet for this species to establish in the wild.

2.3.5 Model Interpretation and validation

The final Maxent model was used to produce predictive maps of the potential distribution of *P. lateralis* across the study area. The maps were then compared to known range maps under the current climate regime in 1981-2010 (Figures 4a and 4b), and under future climate regime from 2021-2040 (Figures 5a and 5b). Expert opinions and ecological species knowledge were used to assess model validity and predictions.

3 General assessments

3.1 Assessment of the magnitude of import of live cockroaches

Cockroaches are one of several popular food items used as live food for lizards and larger invertebrates such as spiders and scorpions. In Norway, seven species of lizards are currently legal to keep as pets. Some of these have a mainly herbivorous diet (especially as adults), including the ocellated spiny-tail lizard (*Uromastyx ocellata* (and to some degree the bearded dragon (*Pogona vitticeps*). Two other species, the Madagascar giant day gecko (*Phelsuma grandis*, previously *P. madagascariensis*) and the crested gecko (*Correlophus ciliates*, previously *Rhacodactylus ciliatus*) mainly feed on special diets (i.e. Repashy Superfood[7]), although these may also feed on live insects as adults. Therefore, only three species of lizard kept in Norway rely on live food items such as cockroaches. According to the leader of the Norwegian Herpetological Society (NHF) Camilla Bjerke (pers. comm.), the most common species to use as live prey is the Argentinian cockroach (*Blaptica dubia*).

It is reasonable to assume that hobbyists who keep spiders and other larger invertebrates in Norway, that require live prey largely utilize *B. dubia*. *Periplaneta lateralis* has no advantages in breeding or keeping that would suggest that this species is a better choice than *B. dubia*, but the fact that there have only been three applications to import *P. lateralis* suggest that the import of these cockroaches to Norway will probably be limited to a few imports of around 50 individuals per year.

3.2 Assessment of import of live cockroaches resulting in establishment

Periplaneta lateralis is a desert- or semi-desert dwelling species that largely lives in hot, arid regions, under climate conditions that we do not expect to find in Norway. To verify, a likely mismatch between climatic niche and environmental conditions in Norway was investigated with a habitat suitability approach (See subchapter 2.3). The resulting maps show the predicted habitats suitable for the species based on the selected environmental variables and occurrence data from both the assumed native range in Asia and the introduced range in North America, based on current climate (Figure 5a), and then predicted future climate conditions (Figure 6a).

The colour gradient employed in the maps illustrates the potential distribution, with darker blue colours indicating lower habitat suitability (zero) whereas lighter yellow shades denote higher suitability (one). Our model output displays the possible suitable habitats across Europe under the current climate regime (Figure 5b) and predicted future climate regime (Figures 6b).

[7] https://www.shop.repashy.com/

The Maxent model predicts that there are suitable habitats around the Mediterranean Sea, mainly in the coastal regions, under the current climate regime (Figure 5b). Most of Europe, and all of Scandinavia has a suitability score of zero.

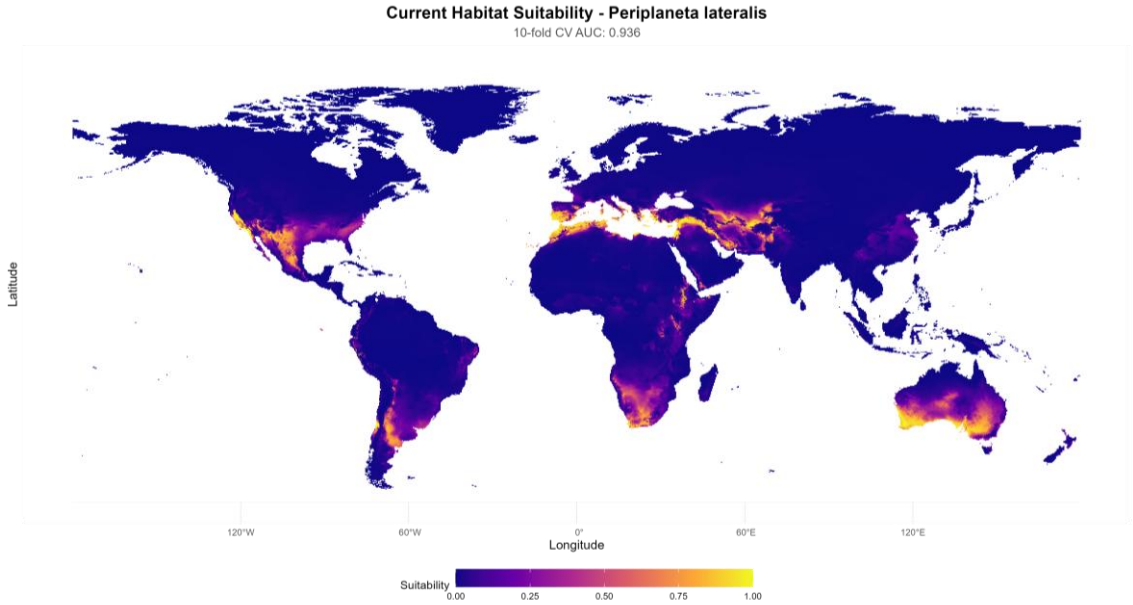

Figure 5a: Worldwide habitat suitability map for *Periplaneta lateralis* under historical (1981-2010) climate conditions. The colour gradient employed in the maps illustrates the potential distribution, with darker blue colours indicating lower habitat suitability (zero) whereas lighter yellow shades denote higher suitability (one)

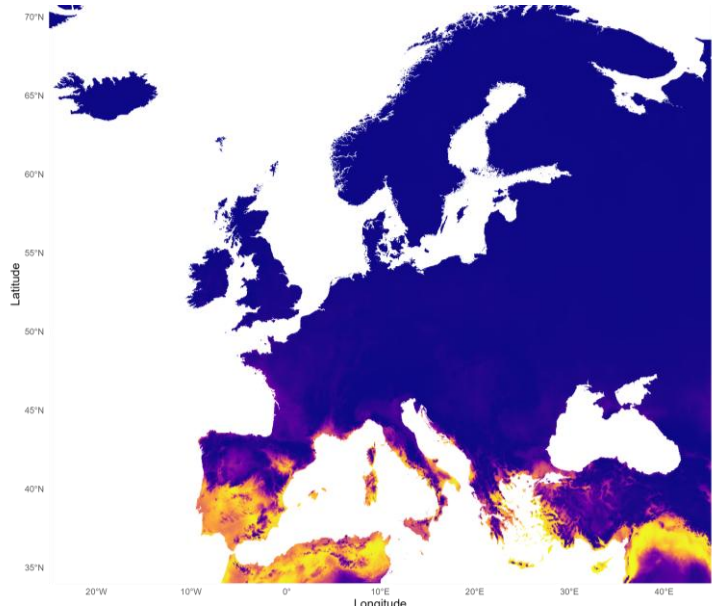

Figure 5b: Habitat suitability map for *Periplaneta lateralis* in Europe under historical (1981-2010) climate conditions. The colour gradient employed in the maps illustrates the potential distribution, with darker blue colours indicating lower habitat suitability (zero) whereas lighter yellow shades denote higher suitability (one)

Taking climate change into account under the conservative scenario ssp245, the model predicted a small change in suitable habitat location, with higher suitability both northwards and southwards, while some existing habitats will become unsuitable. Most of Europe and all of Scandinavia will remain unsuitable (Figure 6b).

As only minor changes in potential northward expansion of suitable habitats are predicted until 2040, VKM assesses that Norwegian outdoor habitats should also remain highly unsuitable for free-living populations of *P. lateralis* until 2100.

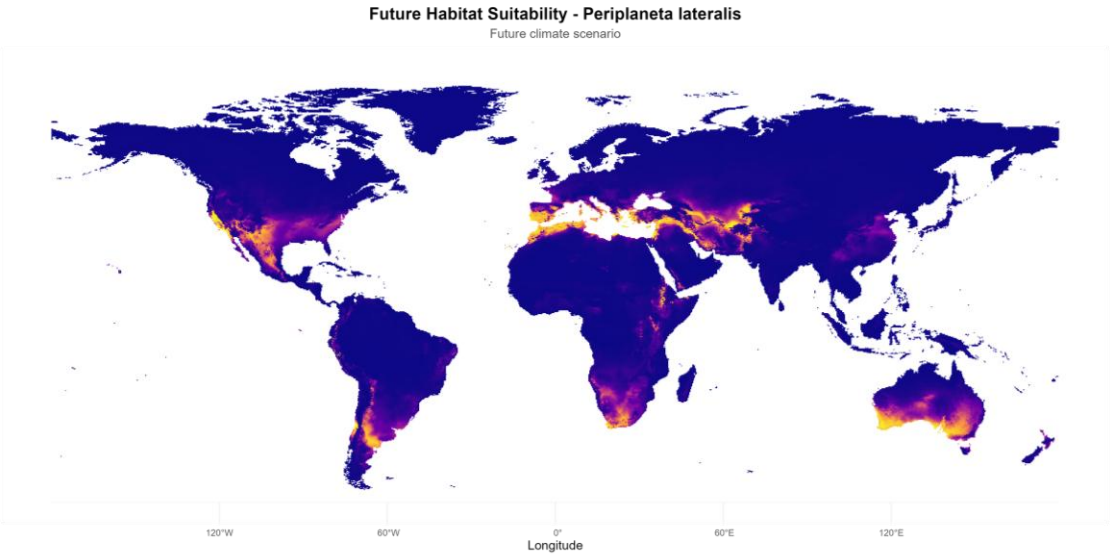

Figure 6a: Worldwide habitat suitability map for *Periplaneta lateralis* under predicted future (until 2040) climate conditions. The colour gradient employed in the maps illustrates the potential distribution, with darker blue colours indicating lower habitat suitability (zero) whereas lighter yellow shades denote higher suitability (one)

However, the current global distribution of the species suggests that *P. lateralis* can establish populations in heated houses, sewage systems and a wide variety of hollow, shaded man-made structures (see Table 1), also under sub-freezing conditions. If imported individuals escape captivity, they might be able to survive and reproduce indoors, also in Norway. Indirect impacts on biodiversity could potentially result from the survival of indoor populations in anthropogenic contexts as non-native cockroaches can maintain disease reservoirs, encounter native species, contaminate food supplies, and transmit pathogens through the cockroaches, to local wildlife. We have, however, not found any reports documenting negative effects on biodiversity from cockroaches in anthropogenic settings. This risk assessment focuses on potential negative effects from *P. lateralis* on Norwegian biodiversity and, although considered a nuisance to humans, establishment and spread in buildings, sewage systems and other man-made environments is not addressed under the mandate of the report.

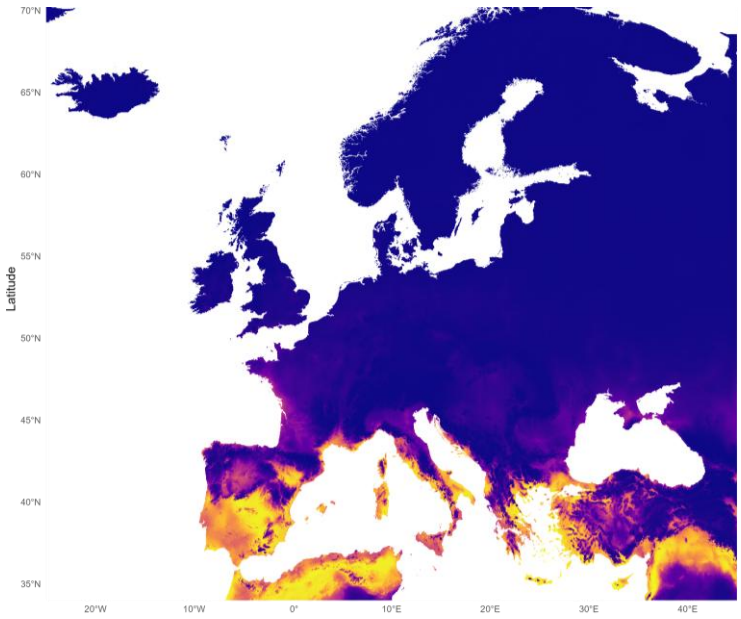

Figure 6b: Habitat suitability map for *Periplaneta lateralis* in Europe under predicted future (until 2040) climate conditions. The colour gradient employed in the maps illustrates the potential distribution, with darker blue colours indicating lower habitat suitability (zero) whereas lighter yellow shades denote higher suitability (one)

3.3 Assessment of relevant impact mechanisms

Based on the available literature, VKM identified two EICAT mechanisms (see 2.1.1 and Table 2 for details) that were relevant to assess for *Periplaneta lateralis:* 1 (competition) and 4 (transmission of disease). Detailed assessments are found in chapter 4.

Grazing/herbivory/browsing were not evaluated because the cockroaches usually feed on dead organic matter and don't attack living plants. Further, there are no native congenerics present to be relevant for hybridisation, and we found no reports of impacts on the abiotic environment including structure, physical or chemical.

4 Risk assessment

4.1 Hazard identification

VKM finds that *P. lateralis* could potentially become a hazard through the two EICAT mechanisms, competition and transmission of disease.

4.1.1 Competition

Periplaneta lateralis is an opportunistic detrivorous species that can feed on almost any organic matter. The cockroach might therefore compete for food with other species with similar diets, including other native or invasive species of cockroaches.

4.1.2 Transmission of disease

Cockroaches, including *Periplaneta lateralis,* are hosts to numerous macro-parasites and fungal, bacterial and viral pathogens. Pathogens and parasites might spread to other animals, including humans, and cause disease (Peterson & Shurdut, 1999).

4.2 Hazard characterisation

The current risk assessment relates to potential negative effects on Norwegian biodiversity and aims to highlight potential negative effects if *P. lateralis* became established in natural habitats in Norway.

4.2.1 Competition

If established in Norwegian nature, *Periplaneta lateralis* might compete with other detrivorous insect species, including the native cockroach *Ectobius lapponicus* (Norwegian *markkakerlakk*) and several species of beetles and woodlice. Of these, we expect competition to be most relevant for the native cockroach (*E. lapponicus*). However, populations of this native species are found in forests and grasslands and not in or around human dwellings (Aleksanov et al., 2025).

We have found very limited information on natural ecosystems where cockroaches in general or *P. lateralis* in particular have displaced native species. Due to the number of studies on cockroaches, we would have expected to find documentation of such trophic processes if competitive displacement can occur. VKM assesses that *P. lateralis*, if established in Norway, will have **minimal** impact (with medium confidence) on native biodiversity.

4.2.2 Transmission of disease

For this mechanism to have any negative effect on Norwegian biodiversity, the imported individuals must be infected by pathogens before arrival in Norway. Details on the pathogen and disease load in *P. lateralis* are largely unknown, making it difficult to assess the potential for transmission to, and consequently negative effects on, native species. Although there are

several studies reporting on parasite load and pathogen prevalence in this, and more studied species of cockroaches, we have not found any reports of transmission of disease agents and parasite from *P. lateralis* to other species. Furthermore, we assume that most imported animals come from professional breeders in Europe[8,9], and are therefore likely to carry fewer pathogens and parasites than free-living individuals. VKM therefore assesses that the hazard will have **minimal** impact (with low confidence).

4.3 Likelihood

4.3.1 Entry

The limited number of applications for importing *Periplaneta lateralis* (currently only three), and anecdotal information that keepers in Norway strongly prefer to use other species as live food for hobby animals, suggest that potential imports of *P. lateralis* are likely to remain very low. Further, species traits that include an incapability for climbing glass or other smooth surfaces and wingless females, combined suggests that the entry of the species into Norwegian nature is **very unlikely** (with medium confidence).

4.3.2 Establishment

Periplaneta lateralis cannot survive temperatures below freezing and 27-30°C is the optimal temperatures for development of ootheca and larvae stages to adults. Also, the species prefer drier environments than are present in Norway. The climatic niche of *P. lateralis* is different from that found in Norway and clearly suggests that it would be **very unlikely** that the species establish in Norwegian nature under current (high confidence) or future climate conditions (medium confidence). The assessment is also confirmed by the results of the habitat suitability modelling shown in Figures 5b and 6b.

4.3.3 Spread

If *P. lateralis* can establish in Norwegian nature, its limited spreading capabilities will make it **very unlikely** that it will be able to spread widely by itself (with medium confidence).

4.4 Risk characterisation

In sum, the VKM find that potential negative effects caused by the Turkestan cockroach to biodiversity in Norway are characterized by the following risks:

[8] https://smallexoticfarm.ie/product/red-runner-periplaneta-lateralis-1-2-5-cm-medium-large/

[9] https://monsieurinsecte.fr/en/products/blatte-red-runner

- **Low risk** with **medium confidence** for competition with other species.
- **Low risk** with **low confidence** for spread of pathogens.

5 Mitigating measures

To protect biodiversity, it is important that cockroaches and their oothecae should not be released into nature, and dead or sick individuals should be disposed in safe ways. Hobbyists, pet shops, and research institutions should be informed about the risks involved and information on proper handling of dead or sick individuals should be made available.

To avoid accidental release, shipments and containers should be escape-proof. Further, importers, wholesalers, and pet shops should have procedures for eradication if a population is detected.

6 Uncertainties

6.1 Uncertainties related to identification of the species

The Turkestan cockroach is similar in appearance to other synanthropic cockroaches so that its presence has sometimes initially been overlooked [USA, Gulmahamad, 2004; Russia: Shilenkov & Suskov, 2009]. Male *P. lateralis* closely resemble *P. americana* whereas female *P. lateralis* are similar to *B. orientalis* (Gulmahamad, 2004; Petersen &Cobb, 2009). Adults can be readily identified correctly from photographs, descriptions or keys, and identification does not require expertise. Several papers and websites have photographs and text that facilitate correct species determination (Davranoglou et al., 2020; de Luna et al., 2021; Taravati, 2022). Cockroaches being sold as Turkestan cockroaches by reputable dealers are likely identified correctly, and there should not be a problem with correctly identifying the species should it escape into urban or wild spaces in Norway. Persistence of older scientific names which are still widely used by insect amateurs and breeders, could lead to problems with monitoring in citizen-science programs or with management activities that require checklists, identification keys, education, or specific actions.

6.2 Uncertainty regarding disease transmission

Cockroaches can carry numerous pathogens and parasites. There are uncertainties related to what the disease agents are that *P. lateralis* might carry. It is also uncertain how native species might develop disease from the pathogens or parasites that might come with introduced individuals of *P. lateralis*.

7 Conclusions

Chapter 7 is structured according to the Terms of Reference (ToR) provided by the Norwegian Environment Agency, which are repeated here with a grey background.

7.1 ToR 1 – Likelihood of establishment

Assess the likelihood of establishment today or in the future given that P. lateralis is introduced. A separate assessment of the likelihood of establishment (including a description of uncertainty) should be conducted.

An assessment of how future climate changes may affect the likelihood of establishment should be included. The assessments should be made from a climate change perspective 10 years into the future and further in a long-term climate perspective.

VKM finds it **very unlikely** that *Periplaneta lateralis* will be able to establish in Norwegian nature. The evaluation is based on the climate conditions in both the assumed native range and known areas where the species has become invasive. Habitat suitability modeling (see Figures 4a and 4b, and 2.3.3 for details) shows that both the current mean annual temperature is too low, the temperature of the coldest quarter is too low, and that conditions are too wet in Norway for this species to survive in natural habitats.

We found only one study providing data on temperature conditions required for development and it documented that development from ootheca to adult took an average of 262 days (males) to 264 days (females) at 27°C. Norwegian summers do not provide such high temperatures over longer time periods and will not do even in the worst-case climate scenarios in a 10 year, or longer, perspective. Therefore, it's very unlikely that the species will be able to reproduce in the wild in Norway.

Studies have also shown that individuals die after 54 hours at -1 °C under laboratory conditions, though we expect the roaches can survive in warmer man-made structures despite freezing outdoor temperatures. Long season periods with freezing temperatures are common all over Norway today and is also expected in the future.

The risk assessment relates to potential negative effects on Norwegian biodiversity. Although *P. lateralis* will not be able to establish in natural ecosystems in Norway it could potentially become established in heated, indoor, environments, at least for parts of the year. However, even permanent establishment were to occur in anthropogenic habitats, there is no vulnerable native biodiversity in these artificial environments, so this scenario has not been assessed further.

The overall conclusion that it is **very unlikely** that *P. lateralis* will become established in Norway, now, in 15 years or even on a longer time scales up to year 2100 (See also Figures 5a and 5b). The assessment has **high confidence** under current climate conditions but comes with increased uncertainty regarding future environmental conditions over long time horizons.

7.2 ToR 2 – Risks to biological diversity in Norway

Assess the risk of adverse effects on biological diversity in Norway from the introduction and keeping of P. lateralis, including a description of uncertainty.

An assessment of how future climate changes may affect the risk of adverse effects should be included. The assessments should be made from a climate change perspective 10 years into the future and further in a long-term climate perspective.

We have identified two EICAT mechanisms by which *P. lateralis* might affect biodiversity in Norway: Competition for food and transmission of disease. For both hazards, VKM concludes that there is low risk (Figure 7), with medium confidence for competition and low confidence for transmission of disease (Figure 8). The reduced confidence is based on the limited studies available on relevant aspects of the species' biology, in particular its climate tolerance and disease and parasite load. This assessment will not be affected by future climate change, neither in a 10-year perspective nor further into the future.

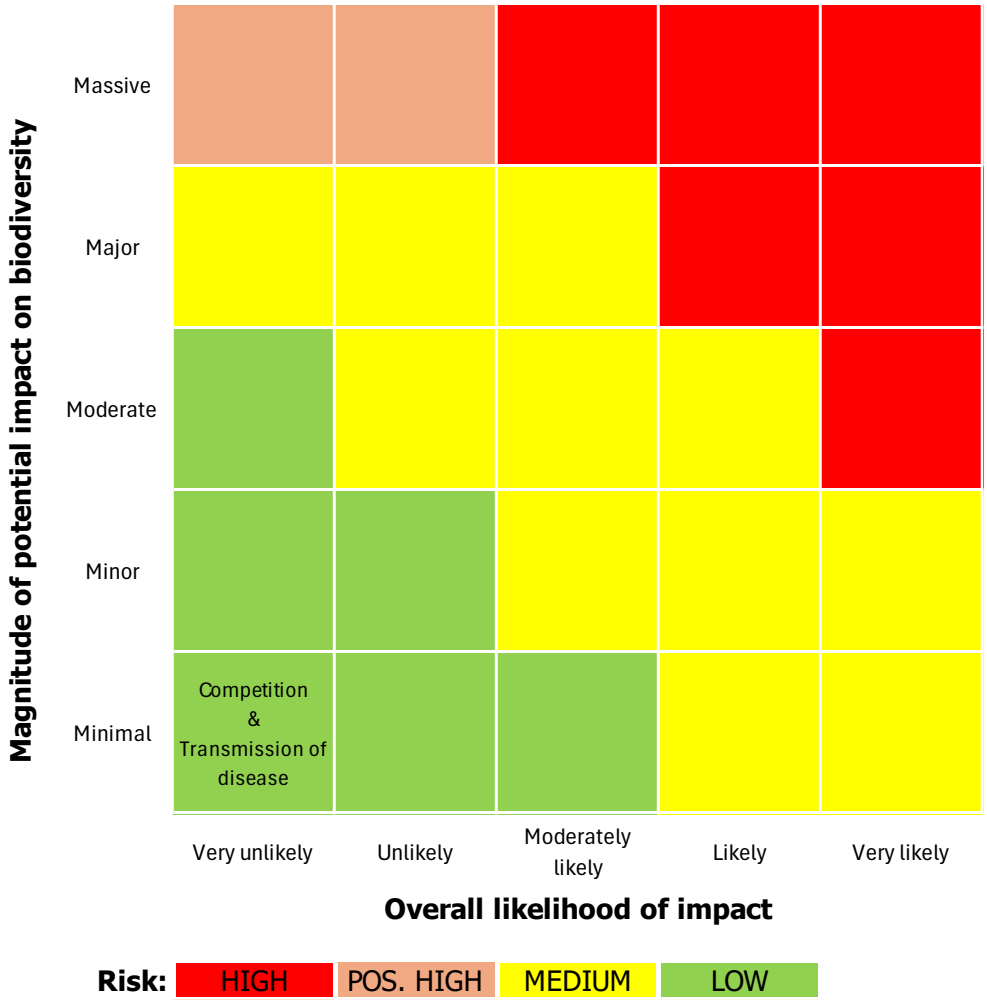

Figure 7: Summary of risks associated with *Periplaneta lateralis* in Norway

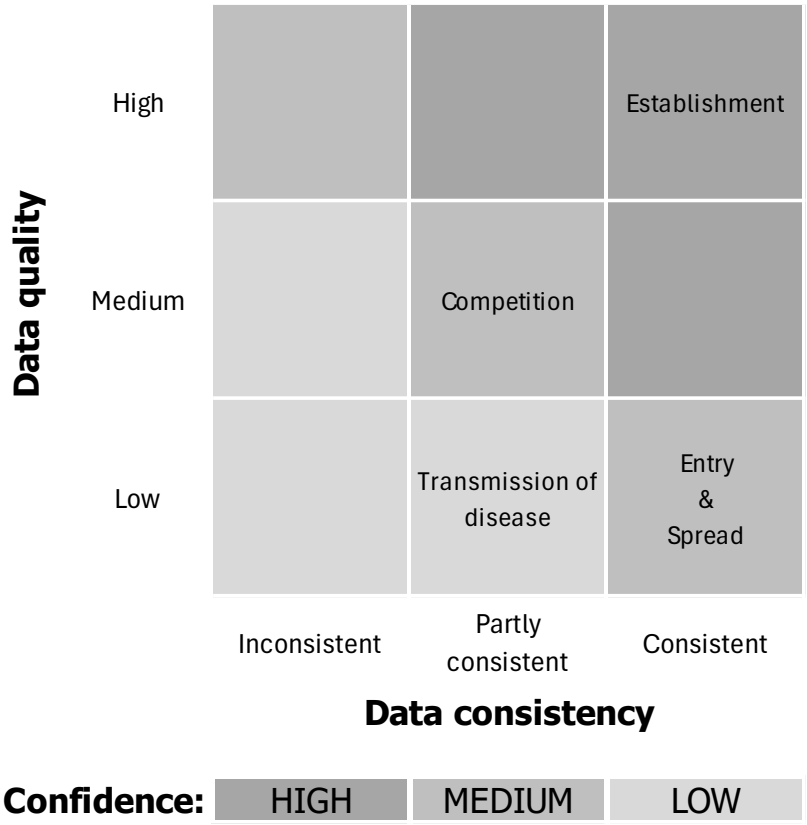

Figure 8: Summary of confidence assessments illustrating the underlaying factors; Data quality and data consistency regarding available information about *Periplaneta lateralis* in Norway.

7.3 ToR 3 – Risk-reducing measures

Identify and describe possible risk-reducing measures, as well as assess the effectiveness of these measures.

To reduce the risk of *Periplaneta lateralis* entering Norwegian nature, we find that several measures can be taken. Providing clear information to importers, pet shops, and hobbyists on the risks involved and on safe handling and disposal of dead or sick individuals will help prevent the spread of potential pathogens. Ensuring that cockroaches and their oothecae are never released into the wild will help protect biodiversity. Requiring escape-proof enclosures will help minimize the risk of individuals escaping and thus prevent establishment. Monitoring around facilities to detect accidental escapes and having procedures for rapid eradication if populations are detected outdoors will help reduce long-term impacts.

8 Data gaps

During the assessment VKM identified the following data gaps, which if could be filled, would strengthen the assessment.

- The original native range of *P. lateralis* is not precisely known and niche modeling was therefore based on presence-only records, which are likely to contain spatial and temporal biases.
- Competitive interactions between native and non-native species of cockroaches have not yet been assessed in controlled trials.
- Lack of information on potential parasites and pathogen load in imported animals, and the potential risk of transmission to native taxa.

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