EU NON-NATIVE ORGANISM RISK ASSESSMENT SCHEME

Name of organism: ***Lepomis gibbosus*** **(Linnaeus, 1758)**
Common names: – Kiver, Pumpkinseed, Common sunfish, Sun bass, Pond perch and Sun perch (GB); slunečnice pestrá (CZ), Gemeiner Sonnenbarsch, Sonnenfisch, Kürbiskernbarsch (DE), Perche soleil (FR), Zonnebaars (NL), solaborre (DK), harilik päikeseahven (EE), aurinkoahven (FI), Solabbor (NO), bass słoneczny (PL), Solechnaya ryba (RU), solabborre (SE), almindelig solaborre (DK), naphal (HU), Perisco sole (IT), soletschnaja pyba (LV), bass sloneczny (PO), biban-soare (RO), soncni ostriz (SL), perca-sol (PT), pez sol (ES).

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EU CHAPPEAU	
QUESTION	**RESPONSE**
1. In how many EU member states has this species been recorded? List them.	It has been recorded in 25 countries: Austria (Copp and Fox, 2007), Belgium (Verreycken et al., 2007), Bulgaria (Copp and Fox, 2007), Croatia (Copp and Fox, 2007), Cyprus (Zogaris *et al*, 2012), Czech Republic (Copp and Fox, 2007), Denmark (Madsen *et al*, 2014), Finland (Urho, unpublished), France (Cucherousset *et al*., 2009), Germany (Nehring *et al*, 2015, Copp *et al*. 2005), Greece (Zenetos *et al*, 2009), Hungary (Tandon, 1977a), Italy (Tandon, 1977b), Latvia (Elvira, 2001), Lithuania (Froese and Pauly (2009), Luxembourg (Copp and Fox, 2007), Netherlands (Van Kleef *et al*., 2008), Poland (Witkowski, 1979), Portugal (Clavero and García-Berthou, 2006), Romania (Skolka and Preda, 2010), Slovakia (Tomoček *et al*., 2005), Slovenia (Povž and Šumer (2005), Spain (Elvira and Almodóvar, 2001), United Kingdom (Fox *et al*, 2007); and Sweden (http://www.smp.se/kronoberg/solabborre-i-asnen-vacker-oro/).
2. In how many EU member states has this species currently established populations? List them.	In Europe it is established in 24 countries. These are: Austria (Copp and Fox, 2007), Belgium (Anseeuw *et al*., 2011), Bulgaria (Yankova, 2016), Croatia, Cyprus, Czech Republic, Denmark (Jensen 2002, Jensen *et al*. 2007), Finland (Urho, unpublished), France (Klaar *et al*. 2004; Cucherousset et al., 2009), Germany (Nehring *et al*, 2015), Greece, Hungary, Italy, Latvia (Cucherousset *et al*., 2009), Lithuania (Elvira, 2001), Luxembourg, Netherlands (Van Kleef *et al*., 2008), Poland, Portugal, Romania (Gavriloaie et al., 2008), Slovakia, Slovenia, Spain (Elvira, 2001), UK (Cucherousset *et al*., 2009).

	 Figure 1. Map showing countries in Europe with pumpkinseed populations. (Fox et al, 2007)
3. In how many EU member states has this species shown signs of invasiveness? List them.	Nine Member States. This species is invasive in Netherlands (Van Kleef *et al*., 2008), Portugal, Romania, Spain, UK (CABI, 2018), and potentially invasive in Germany (Nehring *et al*, 2015), Austria (NOBANIS, 2011), Belgium (Anseeuw *et al*., 2011) and Poland (Grabowska *et al*, 2010; NOBANIS, 2011). It seems to be able to form established populations in almost all countries in Europe (Cucherousset *et al*., 2009).
4. In which EU Biogeographic areas could this species establish?	*Lepomis gibbosus* can tolerate a wide range of climatic conditions. It is established in all biogeographic areas (Fox *et al*, 2007): Continental area, Mediterranean area, Atlantic area, Black Sea area, Pannonian area, Alpine area, Macaronesian area and Steppic Area. It could establish in Boreal area, where population where recorded in Lithuania (Elvira, 2001) and Sweden (http://www.smp.se/kronoberg/solabborre-i-asnen-vacker-oro/). It has demonstrated the ability to establish in colder countries as Norway (Fox et al, 2007) and Ukraine (https://rm.coe.int/national-reports-on-invasive-alien-species/1680717b70), especially in a Climate Change scenario.

5. In how many EU Member States could this species establish in the future [given current climate] (including those where it is already established)? List them.	In Europe it is established in 24 countries. These are: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Italy, Latvia, Lithuania, Luxembourg, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain and UK (see references in Q.2). In the future, *L. gibbosus* could establish in Malta (we have no information about its presence there), Estonia, Ireland, Finland and Sweden (as indicated by the Danish reviewer, Southern Sweden is just as warm or warmer than Denmark, where there are at least ten reproducing populations).
6. In how many EU member states could this species become invasive in the future [given current climate] (where it is not already established)?	There is no information about the presence of this species in Malta, but if present, the conditions to become invasive are met.

SECTION A – Organism Information and Screening

Stage 1. Organism Information	**RESPONSE** **[chose one entry, delete all others]**	**COMMENT**
1. Identify the organism. Is it clearly a single taxonomic entity and can it be adequately distinguished from other entities of the same rank?	Yes	Kingdom: Animalia >> Phylum: Chordata >> Class: Actinopterygii >> Order: Perciformes >> Family: Centrarchidae >> Genus *Lepomis* (Rafinesque, 1819) ***Lepomis gibbosus* (Linnaeus, 1758)** Common names: Kiver, Pumpkinseed, Common sunfish, Sun bass, Pond perch and Sun perch (GB); slunečnice pestrá (CZ), Gemeiner Sonnenbarsch, Sonnenfisch, Kürbiskernbarsch (DE), Perche soleil (FR), Zonnebaars (NL), solaborre (DK), harilik päikeseahven (EE), aurinkoahven (FI), Solabbor (NO), bass słoneczny (PL), Solechnaya ryba (RU), solabborre (SE), almindelig solaborre (DK), naphal (HU), Perisco sole (IT), soletschnaja pyba (LV), bass sloneczny (PO), biban-soare (RO), soncni ostriz (SL), perca-sol (PT), pez sol (ES).
2. If not a single taxonomic entity, can it be redefined? (if necessary use the response box to re-define the organism and carry on)	NA	
3. Does a relevant earlier risk assessment exist? (give details of any previous risk assessment)	Yes	A rapid risk assessment for *Lepomis gibbosus* was produced by the GB Non-native Species Secretariat (GB NNSS) and updated in April 2017. The risk assessment for *Lepomis gibbosus* updated in April 2017 by the GB NNSS describes *L. gibbosus* as an effective competitor of native fish due to plasticity of diet, parental care behaviour which enhances reproductive success, and aggressive behaviour which can affect native species' foraging success, reproduction and microhabitat selection.

These are the conclusions of the study for each risk:

Summary

	Risk	Confidence
Entry	VERY LIKELY	VERY HIGH
Establishment	LIKELY	HIGH
Spread	LIKELY	MEDIUM
Impacts	MODERATE	MEDIUM
Conclusion	MEDIUM	MEDIUM

The Risk screening of non-native freshwater fishes in Croatia and Slovenia undertaken by Piria *et al*. (2016) notified *L. gibbosus* as invasive with a MH (medium high) FISK score.

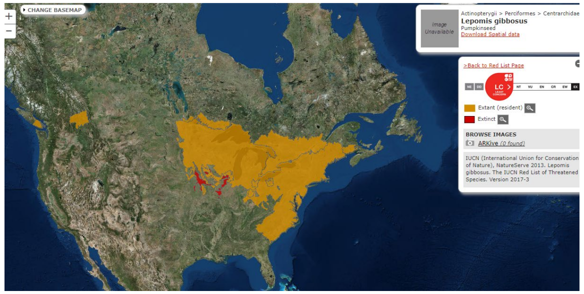
Other risk screenings undertaken in the EU that included *L. gibbosus* are: Ferincz *et. al*. (2016) for Lake Balaton Hungary where the risk of invasiveness was assessed as MH (medium high), Perdikaris *et. al* (2016) for Greece, that assessed the risk of invasiveness for *L. gibbosus* as VH (very high).

L. gibbosus has been subject to FISK assessment for UK, Spain, Portugal (Copp *et al*., 2009; Almeida *et al*., 2013). In all this countries the species was evaluated as a “potential pest”.

There are other risk screenings of *L. gibbosus* undertaken in the EU: For instance in Bulgaria, the species was classified as non-invasive with a medium high (MH) score (Simonovic *et al*., 2013), for Finland *L. gibbosus* was assessed as non-invasive with a medium score (M) (Puntila *et al,* 2013).

In the Black Lists for Germany and Austria, the species was assessed as potentially invasive (Wiesner *et al*. 2010, Nehring *et al*. 2015).

Verbrugge *et al*. (2012) indicated a high risk for *Lepomis gibbosus* in the comparation of risk classifications for 25

		aquatic non-native species using various European risk identification protocols.
4. If there is an earlier risk assessment is it still entirely valid, or only partly valid?	Yes	All risk assessment mentioned above are still valid and we considered them for this RA.
5. Where is the organism native?		*Lepomis gibbosus* is native to the eastern part of North America, where sunfishes are known to have existed since the Miocene (Scott and Crossman, 1973).  Source: IUCN (International Union for Conservation of Nature), *NatureServe* 2013. *Lepomis gibbosus.* The IUCN Red List of Threatened Species. Version 2017-3
6. What is the global distribution of the organism (excluding Europe)?		In addition to its native range, *Lepomis gibbosus* has been introduced in Turkey and Georgia in Asia Minor; Congo and Morocco in Africa; Brazil, Chile, Venezuela, Cuba, and Guatemala in Central and South America, and also in the western parts of the USA and Canada (CABI, 2018).
7. What is the distribution of the organism in Europe?		Lepomis gibbosus is now established in at least 29 countries of Europe and Asia minor. In addition to the countries mentioned above, in Europe it is present in Ukraine (https://rm.coe.int/national-reports-on-invasive-alien-species/1680717b70), Norway (Cucherousset et al., 2009), Switzerland (Wittenberg, 2005), Serbia and Bosnia-Hertzegovina (Copp and Fox, 2007).

8. Is the organism known to be invasive (i.e. to threaten organisms, habitats or ecosystems) anywhere in the world?	Yes	*L. gibbosus* is listed among the top ten introduced fish species with adverse ecological effects (Casal, 2006). It is considered a threat for native fish species (Welcomme, 1988) through competition for food and predation on eggs and juveniles (García-Berthou and Moreno-Amich, 2000). Densities decreases of fish species have been reported to regularly coincide with sharp increases in *L. gibbosus* abundances (Tomoček *et al*., 2007 and literature therein). The species is also held responsible for the locally strong decline and disappearance of endangered amphibians, such as *Pelobates fuscus*, *Triturus cristatus* and *Hyla arborea* (Bosman, 2003; Soes, 2011), gastropods (Wainwright et. al, 1991) and dragonflies (Janssen, 2000), including several species listed in the Council Directive 92/43/EEC (Habitats Directive). Almeida *et al*. (2014) demonstrated how pumpkinseed can disturb, through aggression, the natural behaviours of endemic fauna in Iberian fresh waters, and it highlights the usefulness of direct *in situ* observations to identify aggressive encounters and quantify these under-estimated impacts of invasive species. Van Kleef *et al* (2008) described the decreasing in macroinvertebrate abundance of eight invertebrate taxa (Tricladida, Hirudinea, Oligochaeta, Odonata, Heteroptera, Chironomidae, Ceratopogonidae and Trichoptera) in deteriorated ponds in Netherlands. The results demonstrated a reduction by eighty three percent in pools populated by pumpkinseed than in pools without pumpkinseed, probably due to opportunistic feeding and high pumpkinseed abundance. It should be mentioned that in this study pumpkinseed exploited dredging disturbance and became abundant in ponds

		that had been subject of rehabilitation work to remove invasive plants to favour native plants. Anyway the voracious predation on macroinvertebrate populations can be reproduced, maybe at a lower scale, in more natural ecosystems.
9. Describe any known socio-economic benefits of the organism in the risk assessment area.		*L. gibbosus* is principally a recreational sportfish species, with production in aquaculture facilities for stocking of recreational fishing waters (Dill, 1990) and as ornamental fish for garden ponds. It could be used for scientific research and is also sold in the aquarium trade (CABI, 2018, Van der Valk *et al*., 2018). The importance for sport-fishing of *Lepomis gibbosus* is very low, and it is considered as a pest by sport anglers. Maybe this species can contribute to decrease mosquito populations in invaded areas. Unfortunately there is a lack of scientific information on these economic issues. As an exemple, in the NL trade value is low and has been recently estimated to be 20.000 Euro per year (Van der Valk *et al*., 2018), excluding web trade. However, volume and trade value of (inter)nation web trade is unknown.

SECTION B – Detailed assessment

PROBABILITY OF ENTRY

Important instructions:

- Entry is the introduction of an organism into Europe. Not to be confused with spread, the movement of an organism within Europe.
- For organisms which are already present in Europe, only complete the entry section for current active pathways of entry or if relevant potential future pathways. The entry section need not be completed for organisms which have entered in the past and have no current pathways of entry.

QUESTION	RESPONSE [chose one entry, delete all others]	CONFIDENCE [chose one entry, delete all others]	COMMENT
1.1. How many active pathways are relevant to the potential entry of this organism? (If there are no active pathways or potential future pathways respond N/A and move to the Establishment section)	moderate number	medium	The Pumpkinseed (*Lepomis gibbosus*) was introduced to Europe in the 1880s for use in outdoor ponds and as aquarium fish (Hanel, 2011, CABI, 2018). It was stocked in gardens as well as in aquaria, and released through accidental or deliberate releases to different water bodies (Tandon, 1976; Geiter *et al*., 2002). The main introduction pathways was as an ornamental fish including stocking in outdoor ponds as well as in aquaria (e.g. United Kingdom; Netherlands; Poland), sport fishing (Germany) (Nehring *et al*, 2015) or for extensive fish culture for use as forage food for largemouth bass (Spain and Portugal (CABI, 2018) and more recently as a pet fish, i.e. for indoor aquaria. In France it was first introduced as a scientific (and then anglers) curiosity (Poulet, 2017, French revision of the *Lepomis* genus RA draft).

			Some authors also assume that *L. gibbosus* could be introduced unintentionally, for instance with imports of carp fry used in stocking (Tandon, 1976). *L. gibbosus* has also been deliberately introduced in Denmark in the belief that it can control the fish louse *Argulus foliaceus* (Przybylski and Zięba, 2011). The species has already entered Europe and introduction pathways are still open, suggesting further introductions are possible. As seen before, the species is present in high abundance in many countries in mainland Europe and it is possible that accidental introductions could occur, with *L. gibbosus* as a contaminant of a legal fish stocking from Europe and from regulated fish movements within new locations (Davies *et al*. 2013).
1.2. List relevant pathways through which the organism could enter. Where possible give detail about the specific origins and end points of the pathways. For each pathway answer questions 1.3 to 1.10 (copy and paste additional rows at the end of this section as necessary).	[Pet trade /Ornamental fish] [Sport fishing] [Contaminant of fish stock] [Forage fish]		*Lepomis gibbosus* is largely known as invader and is present in almost all European countries. Nowadays the species could still entry as: - Ornamental pet; - Sportfishing; - Contaminant of fish stock - accidental introductions with legal fish stocking; - Forage fish/Bait/Fodder (less probable).
Pathway name:	[Pet trade /Ornamental fish]		
1.3. Is entry along this pathway intentional (e.g. the organism is imported for trade) or accidental (the organism is a contaminant of imported goods)? (If intentional, only answer questions 1.4, 1.9, 1.10, 1.11)	intentional	medium	*Lepomis* species are intentionally imported for aquariums or garden lagoons. It seems that demand has decreased but this species is still on the market. For instance in the NL trade value has been recently estimated to be 20.000€ per year (Van der Valk et al., 2018), excluding web trade.

1.4. How likely is it that large numbers of the organism will travel along this pathway from the point(s) of origin over the course of one year? Subnote: In your comment discuss how likely the organism is to get onto the pathway in the first place.	unlikely	low	Over the course of one year it is not expected that a large number of organism would enter in Europe. Entries from North America are very unlikely but it can be traded between European countries.
1.9. How likely is the organism to be able to transfer from the pathway to a suitable habitat or host?	very likely	high	Pets are released into the wild when owners don't want to keep them anymore.
1.10. Estimate the overall likelihood of entry into Europe based on this pathway?	moderately likely	low	Trade can be done between European countries. The probability of new entries of *Lepomis* species with the pet-trade from North America is not very likely, depending on trends in aquaristic.
End of pathway assessment, repeat as necessary.			
Pathway name:	[Sport fishing]		
1.3. Is entry along this pathway intentional (e.g. the organism is imported for trade) or accidental (the organism is a contaminant of imported goods)? (If intentional, only answer questions 1.4, 1.9, 1.10, 1.11)	intentional	medium	*Lepomis gibbosus* has been intentionally imported for fishing activities in many parts of Europe. Today it is perceived more like an annoyance for the anglers, and the demand has decreased. But entry as stocks for sport fishing could still happen in some parts of Europe.
1.4. How likely is it that large numbers of the organism will travel along this pathway from the point(s) of origin over the course of one year? Subnote: In your comment discuss how likely the organism is to get onto the pathway in the first place.	unlikely	low	Over the course of one year it is not expected that a large number of organism would enter in Europe. Imports from North America are not expected, because anglers take them from established populations in Europe.
1.9. How likely is the organism to be able to transfer from the pathway to a suitable habitat or host?	likely	medium	Once entered, *L. gibbosus* could easily be introduced to a suitable habitat given the large number of suitable habitats and demonstrated generalist behaviour.

1.10. Estimate the overall likelihood of entry into Europe based on this pathway?	moderately likely	low	We consider it moderately likely because the demand for this fish decreased but it is still probable. However we recognize low confidence in the answer.
End of pathway assessment, repeat as necessary.			
Pathway name:	[Contaminant of fish stock]		
1.3. Is entry along this pathway intentional (e.g. the organism is imported for trade) or accidental (the organism is a contaminant of imported goods)? (If intentional, only answer questions 1.4, 1.9, 1.10, 1.11)	unintentional	medium	*L. gibbosus* has also been reported to have been imported into the former Czechoslovakia inadvertently with young carp (Tandon, 1976). As mentioned by GB NNSS (2017), accidental introductions could occur with legal fish stocking from Europe and regulated fish movements within UK. Another species of *Lepomis, L. cyanellus,* was introduced outside its native area with other intended species as a stock contaminant (Dill and Cordone, 1997).
1.4. How likely is it that large numbers of the organism will travel along this pathway from the point(s) of origin over the course of one year? Subnote: In your comment discuss how likely the organism is to get onto the pathway in the first place.	unlikely	low	Over the course of one year it is not expected that a large number of organism would enter in Europe. Entries from North America as contaminant are very unlikely but once entered, trade can be done between European countries (GB NNSS, 2017).
1.5. How likely is the organism to survive during passage along the pathway (excluding management practices that would kill the organism)? Subnote: In your comment consider whether the organism could multiply along the pathway.	moderately likely	medium	*Lepomis gibbosus* have a high morphological, physiological, and behavioral adaptability to their new environment (Gross and Charnov, 1980; Ehlinger *et al.* 1997), this characteristics could make its survival and reproduction possible along the pathway.
1.6. How likely is the organism to survive existing management practices during passage along the pathway?	moderately likely	low	Giving their high tolerance and characteristics of survivors it is to expect to survive along the pathway even if management practices take place.

1.7. How likely is the organism to enter Europe undetected?	moderately likely	low	Based on the experience, this possibility is not to be discarded. *L. gibbosus* and *L. cyanellus* and many other fish species were introduced into other areas as a stock contaminant in the past (Tandon, 1976; Dill and Cordone, 1997).
1.8. How likely is the organism to arrive during the months of the year most appropriate for establishment?	likely	medium	In Europe there are many areas with a climate that is similar to the east of North America. It is expected that fish stockings occur between spring and autumn, which is also suitable for *L. gibbosus*.
1.9. How likely is the organism to be able to transfer from the pathway to a suitable habitat or host?	likely	medium	Once entered, *L. gibbosus* could easily be introduced to a suitable habitat.
1.10. Estimate the overall likelihood of entry into Europe based on this pathway?	moderately likely	medium	We consider it moderately likely. Many species of fish entered unintentionally as a stock contaminant.
End of pathway assessment, repeat as necessary.			
Pathway name:	[Forage fish]		
1.3. Is entry along this pathway intentional (e.g. the organism is imported for trade) or accidental (the organism is a contaminant of imported goods)? (If intentional, only answer questions 1.4, 1.9, 1.10, 1.11)	intentional	medium	The introduction and spread of major predators in Spain, such as the pike *Esox lucius* L., largemouth bass *Micropterus salmoides,* wels catfish *Silurus glanis* L., European perch *Perca fluviatilis* L., and zander *Stizostedion lucioperca* (L.), created the need to introduce and spread forage species, such as *Lepomis gibbosus* (L.) and other species, which are more closely adapted to survive alongside the predator (Elvira and Amodóvar, 2001). Along this pathway, also *L. macrochirus* was introduced across the United States (as forage fish for *Micropterus salmoides*, Kawamura *et al*. 2010).

			This pathway is unlikely nowadays but it is not to be discarded completely.
1.4. How likely is it that large numbers of the organism will travel along this pathway from the point(s) of origin over the course of one year? Subnote: In your comment discuss how likely the organism is to get onto the pathway in the first place.	unlikely	medium	Over the course of one year it is not expected that a large number of organism would enter in Europe. Entries from North America are unlikely, but in the past introductions of *Lepomis* spp. happened because of using it as forage food in South America and Africa (Welcomme, 1988).
1.9. How likely is the organism to be able to transfer from the pathway to a suitable habitat or host?	very likely	high	Once entered the organism could easily be introduced to a suitable habitat.
1.10. Estimate the overall likelihood of entry into Europe based on this pathway?	unlikely	low	There are no further informations, but this pathway should not be discarded as pumpkinseed could be imported as fodder or bait and for other species.
End of pathway assessment, repeat as necessary.			
1.11. Estimate the overall likelihood of entry into Europe based on all pathways (comment on the key issues that lead to this conclusion).	moderately likely	medium	*Lepomis gibbosus* is already widely introduced in Europe. Introduction pathways are still open, suggesting further introductions are possible. Due to disease controls under the Aquatic Animal Health Regulations in the EU, there is now very limited fish movement trade with Europe and certainly none directly to fisheries and the wild. In addition, license requirements under the ILFA (Import of Live Fish Act) orders have severely restricted demand and the ornamental and pet trade for *L. gibbosus*. While these restrictions will have reduced the risk of new introductions they have not eliminated the risk entirely.

PROBABILITY OF ESTABLISHMENT

Important instructions:

- For organisms which are already well established in Europe, only complete questions 1.15 and 1.21 then move onto the spread section. If uncertain, check with the Non-native Species Secretariat.

QUESTION	RESPONSE	CONFIDENCE	COMMENT
1.15. How widespread are habitats or species necessary for the survival, development and multiplication of the organism in Europe?	widespread	very high	The habitats suitable for survival, development and multiplication are widespread. *L. gibbosus* can be found in small lakes, ponds, shallow, weedy bays of larger lakes, and in the quiet water of slow-moving streams (Scott and Crossman, 1973). Taking into account the generalist behaviour of this species, it could invade almost all the water surfaces, primarily downstream sections of small to-medium-sized streams of low gradient, ponds and backwaters of large rivers and silty, soft bottomed areas of lakes and impoundments. Fast flowing streams and rivers are generally avoided, but still they are found in slow moving parts within this habitat (Scott and Crossman, 1973). A preference for very shallow water when nest building is exhibited (van Kleef *et al*. 2008), indicating that reservoirs and heavily managed lotic systems would provide suitable habitat for establishment.

1.21. How likely is it that biological properties of the organism would allow it to survive eradication campaigns in Europe?	likely	high	In small ponds it is possible to manipulate numbers by removing fish regularly. In larger ponds this is often not practical and the only possibility to remove *L. gibbosus*, is to drain the entire pond. It is not without reason that it is often advised just to keep only one *L. gibbosus* per garden pond. The males take care of the eggs and young till they can successfully evade most other pond fish and have a high survival rate (Soes *et al*. 2011). In small streams, lakes or ponds, control and eradication techniques could be successfully employed to extirpate or suppress isolated populations (Ling, 2003; Britton *et al*., 2010; Davies and Britton, 2015). But when it is established in a large lake or river system, fish in general are nearly impossible to eradicate (https://freshwaterhabitats.org.uk/wp-content/uploads/2013/09/Controlling-Fish-Sept-2010-1.pdf). Their biological characteristics such as parental care, high survival rate, fecundity, lifespan and high tolerance (Marchetti *et al*, 2004) would allow species to adapt in response to changes in biotic and abiotic conditions and to survive control methods as for instance: removing exemplars, draining the pond.

PROBABILITY OF SPREAD

Important notes:

- Spread is defined as the expansion of the geographical distribution of a pest within an area.

QUESTION	RESPONSE	CONFIDENCE	COMMENT
2.1. How important is the expected spread of this organism in Europe by natural means? (Please list and comment on the mechanisms for natural spread.)	major	high	*L. gibbosus* is known to disperse via natural drift in water courses (e.g. Copp and Cellot, 1988), from water bodies that discharge into water courses (Stakenas *et al*., 2008), and to move actively within water courses (Copp et al., 2010). Once they are introduced, *Lepomis gibbosus* have a high morphological, physiological, and behavioral adaptability to their new environment (Gross and Charnov, 1980; Ehlinger *et al*. 1997), so natural expansion is to be expected. Spread of *L. gibbosus* propagules in hydrologically connected waterbodies has been demonstrated (Fobert *et al*, 2013). As described by Gavriloaie (2007), from Germany *L. gibbosus* extended through the Rhine, Oder and Danube towards Eastern Europe. In recent years, the species spread rapidly into the Bulgarian inland water bodies (Yankova, 2016). In UK, as this species has already established in over thirty sites, it is likely that further dispersal will occur (GB NNSS, 2017).

2.2. How important is the expected spread of this organism in Europe by human assistance? (Please list and comment on the mechanisms for human-assisted spread.)	major	medium	Humans have been demonstrated to be the main vector in the dispersal of non-native fish (Trombulac and Frissell, 2000; Copp *et al*., 2005). The likelihood of introduction is related to the accessibility of the pond. Human assistance in the spread of *L. gibbosus* (e.g. by anglers) appears to be a usual practice, more common in southern Europe. For instance in Cyprus *L. gibbosus* was released intentionally in water reservoirs by amateur fishermen and spread after 2009 when became established in almost all reservoirs and some lakes on the island. As established *L. gibbosus* populations are already present in lentic waters, there is also a risk of inadvertent transfer, with consignments of other fish species destined for recreational stocking enhancements (Davies *et al*. 2013; Villeneuve *et al*. 2005; Copp *et al*. 2007). Some countries like France (Arrêté du 17/12/1985) have forbidden new entries of all *Lepomis* spp, so human-assisted spread should become less important.
2.3. Within Europe, how difficult would it be to contain the organism?	difficult	high	The organism is present and established in almost all EU countries and it is very difficult to control its expansion.
2.4. Based on the answers to questions on the potential for establishment and spread in Europe, define the area endangered by the organism.	[Most of central and southern Europe and parts of north Europe]	high	*L. gibbosus* is present in at least 25 European member states, and established in 24 member states. See also answers to questions 5 and 6 of EU CHAPPEAU
2.5. What proportion (%) of the area/habitat suitable for establishment (i.e. those parts of Europe were the species	33-67	medium	Given the high number of countries in which *L. gibbosus* is established, as well as its adaptability, it is

could establish), if any, has already been colonised by the organism?			estimated that between one and two thirds of the potential area is already colonised.
2.6. What proportion (%) of the area/habitat suitable for establishment, if any, do you expect to have been invaded by the organism five years from now (including any current presence)?	33-67	low	Given the recent colonization of *L. gibbosus* it is estimated that its colonization within the next five-years may be of this order.
2.7. What other timeframe (in years) would be appropriate to estimate any significant further spread of the organism in Europe? (Please comment on why this timeframe is chosen.)	30-40	medium	Since 1930, and probably earlier, the pumpkinseed is present in the Danube River. About 30 – 40 years later new locations started to appear. All of them are Danube's online marshes, tributaries and a reservoir. Danube tributaries located further upstream were later found to contain pumpkinseed approximately simultaneously (Yankova, 2016). Considering the conditions in which *L. gibbosus* had spread in the past, further spread can be significant in this period. If taking into consideration climate warming and the deterioration of habitat, this interval could be shorter.
2.8. In this timeframe what proportion (%) of the endangered area/habitat (including any currently occupied areas/habitats) is likely to have been invaded by this organism?	67-90	low	There is no information about the endangered areas/habitats occupied by the species, but given the situation of the wetlands and river-basins and the history of *L. gibbosus* in Europe, it is estimated that it could be of the order of this proportion.
2.9. Estimate the overall potential for future spread for this organism in Europe (using the comment box to indicate any key issues).	rapidly	high	Initially widely introduced across Europe it continues to spread as a result of releases from aquaria and by accidental inclusions when other fish are transferred. The absence of the major sunfish competitors helps also to a successful spread.

			In either case, the evolution and maintenance of more opportunistic traits in European pumpkinseed can likely be attributed to enemy release, and this may explain the successful establishment and spread of pumpkinseed in many parts of Europe. Thus, while 'r-selected' life-history traits may be favoured during the initial stages of a species' establishment and spread in a novel environment because of low density and, in many cases, high food availability per individual, 'K-selected' life-history traits, like lower reproductive investment and greater investment in individual offspring, may be favoured where density levels are high enough to produce a more competitive environment (Fox *et al,* 2007). Pumpkinseed populations in the lower Danube (Romania) are also thought to have been derived from downstream dispersal of escapee fish from Hungarian fish farms (Manea, 1985). With increased survival and recruitment under conditions of a warmer climate, and life history traits that enable colonisation and establishment in novel environments, the pumpkinseed will be able to exploit the increased hydrological variability and the extensive connectivity of canals and water course in southern England to expand its introduced range. In conclusion *L. gibbosus* has a high potential for future spread.

PROBABILITY OF IMPACT

Important instructions:

- When assessing potential future impacts, climate change should not be taken into account. This is done in later questions at the end of the assessment.
- Where one type of impact may affect another (e.g. disease may also cause economic impact) the assessor should try to separate the effects (e.g. in this case note the economic impact of disease in the response and comments of the disease question, but do not include them in the economic section).
- Note questions 2.10-2.14 relate to economic impact and 2.15-2.21 to environmental impact. Each set of questions starts with the impact elsewhere in the world, then considers impacts in Europe separating known impacts to date (i.e. past and current impacts) from potential future impacts. Key words are in bold for emphasis.

QUESTION	RESPONSE	CONFIDENCE	COMMENTS
2.10. How great is the economic loss caused by the organism within its existing geographic range, including the cost of any current management?	unknown	low	There is no information available regarding the economic impacts of *L. gibbosus* in its introduced range (CABI, 2018) but most of the states where it is introduced have complaints. Economic impacts are often difficult to assess and to quantify. We appreciate that the degree of impact cannot be quantified because there is a lack of information. However a lack of knowledge may never be interpreted as absence of adverse impacts (Davis, 2009).
2.11. How great is the economic cost of the organism currently in Europe excluding management costs (include any past costs in your response)?	unknown	low	There is no information available regarding the economic impacts of *Lepomis* spp. in its introduced range. But the loss of native species should be seen in terms of economic loss. Oreska and Aldridge (2011) cite *Lepomis gibbosus* as not very likely to cause economic impacts in Great Britain, and affirm that stakeholders do not view such species as

			pests. GB NNSS (2017) however considers that *L. gibbosus* may cause some loss of income to recreational fisheries by reducing their native fish populations through competition. *Lepomis gibbosus* is not an appreciate sport fish in Europe. That implies a loss in the value of a lake where this species is established for sportfishing.
2.12. How great is the economic cost of the organism likely to be in the future in Europe excluding management costs?	unknown	low	There are no studies regarding the current economic costs but if thinking about the efforts to avoid loss of native species and loss of ecosystem services this cost may only grow in the future.
2.13. How great are the economic costs associated with managing this organism currently in Europe (include any past costs in your response)?	moderate	low	The main constraint is the lack of species-specific eradication techniques to be applied to fish (Scalera and Zaghi, 2004). When established, centrarchid populations can in most instances only be eradicated with rigorous measurements like dewatering or the use of piscicides. There are no eradication studies specific for *Lepomis* spp. But we can take as reference the cost of the interventions to eradicate other freshwater non-native fish in Europe, as: -*A. melas* in North London: the eradication costed of approx. £5000.00 (€6356.00). £10,000.00, including manpower costs (APHA-Animal and Plant Health Agency, personal comm., 2015) or -*P. parva* in England: eradication with rotenone costed about £2 per m^2 of water area treated (Britton *et al*, 2010). -*Cyprinus carpio* and *Gambusia affinis* in an endoreic lagoon (37 Ha) in south of Spain. The eradication of

			these two invasive species (cost about 300.000 € (Fernández-Delgado, comm. pers. 2017). One might also consider *L. gibbosus* control by removing part of the population on a yearly or bi-yearly basis. Although, the species would not be locally eradicated, its numbers would be suppressed and ecological damage reduced. If yearly fishing is a management option then using funnel traps could be considered. These traps are being used by researchers and are very effective in catching age 2 and older pumpkinseed (Fox and Keast, 1990; Fox, 1994).
2.14. How great are the economic costs associated with managing this organism likely to be in the future in Europe?	moderate	low	Considering the data above it is supposed that the management of this species would imply some economic costs in the future in Europe. An effective audit procedure using experienced auditors and high search effort reduces this risk of being accidentally introduced. Implementation should help prevent subsequent invasions, protecting native species from their adverse ecological consequences (Davies *et al*, 2013.
2.15. How important is environmental harm caused by the organism within its existing geographic range excluding Europe?	major	high	Many aquatic ecosystems where pumpkinseed have been introduced have suffered direct and indirect impacts related to habitat disruption and competition for resources (Dextrase and Mandrak, 2006). Introduced pumpkinseed are considered a factor in the decline of 7 out of 41 endangered fish species in Canada (Dextrase and Mandrak, 2006). Benthic invertebrate diversity and density is likely to be reduced significantly as a result of reproductive behaviour and nest building (Thorp, 1988).

			A five years old female pumpkinseed can produce from 1,950 to 2,923 eggs per spawning (Wydoski and Whitney 1979). These abundant fry out compete the trout for space and food, and consume trout fry (Washington Department of Fish and Wildlife 2002). In Arizona, where it has also been introduced, it is considered a pest. It rarely achieves a size desired by anglers, and often forms a stunted population that competes with more desirable fishes (Minckley, 1973)
2.16. How important is the impact of the organism on biodiversity (e.g. decline in native species, changes in native species communities, hybridisation) currently in Europe (include any past impact in your response)?	major	high	Adverse impact has been demonstrated by several authors. For instance Casal (2006) cited *L. gibbosus* among the top ten introduced fish species with adverse ecological effects, as well as Welcomme (1988), García-Berthou and Moreno-Amich (2000), van Kleef *et al*. (2008). Tomoček *et al*. (2007) observed a decreases in the densities of fish while increasing *L. gibbosus* abundances. The species is also held responsible for the locally strong decline and disappearance of endangered amphibians, such as *Pelobates fuscus*, *Triturus cristatus* and *Hyla arborea* (Bosman, 2003; Soes, 2011), gastropods (Wainwright et. al, 1991) and dragonflies (Janssen, 2000), including several species listed in the Council Directive 92/43/EEC (Habitats Directive). Introduction of *L. gibbosus* into Spain and Portugal provoqued aggression on native lotic species (Almeida *et al*. 2014).

			The Lake Banyoles in Catalonia is nowadays dominated by alien species. In the littoral zone, the most common fish species are *Micropterus salmoides* and *Lepomis gibbosus*. The occurrence of non-native fish-predators in Spain and Portugal freshwaters, is probably one of the main detrimental factors influencing the survival of endemic species (mostly Cyprinidae and Cobitidae). Some authors described the important impact of invasive species as *Lepomis gibbosus* on vulnerable native or endemic species, as: *Anaecypris hispanica, Salaria fluviatilis* (Blanco-Garrido *et al,* 2009), *Aphanius iberus, Luciobarbus guiraonis, Luciobarbus haasi, Luciobarbus comizo, Chondrostoma lemmingii Chondrostoma miegii, Gobio gobio, Squalius cephalus*, *Squalius pyrenaicus*, *Cobitis paludica, Valencia hispanica* etc. (Elvira, 1997; Doadrio, 2002). In Flanders it was demonstrated that nesting activity resulted in a destabilizing process of *Littorella uniflora* plants, an endangered species in the Netherlands (Soes *et al*., 2011). In France *Lepomis gibbosus* was find responsible for the extinction of white-clawed crayfish (*Austropotamobius pallipes*) in one of the seven ponds in the natural reserve of Pinail (Vienne department) (Bramard *et al*, 2006). van Kleef *et al*. (2008) demonstrated negative impacts on macroinvertebrate fauna in waterbodies in the Netherlands, albeit in a highly modified environment. Also according to Anseeuw *et al*. (2011) this predatory fish can occur in very high numbers and impact the native

			fauna by feeding on aquatic invertebrates, larvae of amphibians and fish eggs and fry. The main response of the recipient species to aggression from all sizes of *L. gibbosus* was retreat, specifically with no return (i.e. the strongest behavioural impact of the aggression) when aggressors were medium or large pumpkinseed. These results highlight the true potential for adverse impact of *L. gibbosus* through behavioural interference, resulting in the physical displacement of native species from essential resources (e.g. food or habitat), with the subsequent expenditure of energy to avoid the aggressor. In relation to recipient species, the results of the study carried out by Almeida *et al*. (2014) showed that *L. gibbosus*, particularly medium and large sizes, can display aggression on a wide range of taxonomic groups with different ecological requirements, including species at the stream margins (mosquitofish, frog), in the water column (calandino, chub) or on the river bed (crayfish, loach). Previous studies have also shown impacts of pumpkinseed on a variety of functional groups, including zooplankton (Angeler *et al* 2002), macrobenthos (van Kleef *et al* 2008), crayfishes (Bramard *et al* 2006), fishes (Declerck *et al* 2002) and amphibians (Bosman, 2003; Hartel *et al* 2007; Soes, 2011). Some studies in GB have found no evidence of ecological impact (Copp *et al*. 2010; Vilizzi *et al*. 2012; Stakenas *et al*. 2013) detected little evidence of negative interactions between *L. gibbosus* and native brown trout *Salmo trutta* in English streams. Nevertheless Fobert *et al* (2013) concluded that although pumpkinseed are not currently considered invasive in the

			United Kingdom, the pumpkinseed's status in this region is likely to shift to invasive under predicted future conditions. Limited food supplies, less than ideal climate and lack of establishment in streams where they have been introduced have been offered as explanations (Klaar *et al*. 2004). Some of these factors could be overcome in the future. Propagule pressure in the form of continued introduction of fish from the main source to the out lying streams could lead to successful establishment, as could a climate change due to global warming (Klaar *et al*. 2004; Villeneuve *et al*. 2005). Demonstrated trophic interactions (Gkenas *et al*., 2016) and alterations in abiotic conditions of reservoirs (Naspleda *et al*., 2012) can lead to a negative impact of pumpkinseed on biodiversity.
2.17. How important is the impact of the organism on biodiversity likely to be in the future in Europe?	major	medium	Gkenas *et al*. (2016) demonstrated a shift in dietary specialization from establishment to integration, suggesting that potential ecological effects of *L. gibbosus* introductions can vary with invasion step. Increased water temperatures as a result of climate change will extend the reproductive season of *Lepomis* species and likelihood of progeny survival. Larger body sizes and increased growth rates may also lead to a greater impact on native fauna (Eaton, 1996).
2.18. How important is alteration of ecosystem function (e.g. habitat change, nutrient cycling, trophic interactions), including losses to ecosystem services, caused by the organism currently in Europe (include any past impact in your response)?	moderate	medium	*Lepomis gibbosus* is a successful invader in Europe, where it has caused negative ecological effects primarily through trophic interactions. Pumpkinseed showed a shift from trophic specialization (on chironomids) during establishment to trophic generalism during integration.

			These results were concomitant with an increase in diet breadth that was accompanied by higher individual diet specialization particularly in large individuals (Gkenas *et al*., 2016). As mentioned before, demonstrated trophic interactions and alterations in abiotic conditions of reservoirs (Naspleda *et al*., 2012) can lead to a negative impact of pumpkinseed on ecosystem function. The loss of species (van Kleef *et al,* Bramard *et al* 2006, Declerck *et al* 2002, Bosman, 2003; Hartel *et al* 2007; Soes, 2011), as well as the transformation of the habitat and modification of its natural conditions, such as increased turbidity (Naspleda *et al*., 2012, Angeler *et al*., 2002), supposes an important effect on the function of ecosystems. The pumpkinseed affects the quality of the water, increasing the levels of chlorophyll and turbidity and the concentrations of nitrogen and phosphorus. This suggests that the introduction of this species in wetlands can be a threat to the functioning of ecological processes that occur within these wetlands (Naspleda *et al*., 2012). *L. gibbosus* has been shown to enhance water turbidity and concentrations of phosphorus and nitrogen (Angeler *et al*., 2002). As these substances are important nutrients for plant growth, increased concentrations can lead to shifts in plant species composition and changes in ecosystem functioning. During a pilot study in the moorland pool “Zwart water” in Flanders it was demonstrated that nesting activity resulted in a destabilizing process of *Littorella uniflora* plants, an endangered species in the Netherlands (Soes *et al*., 2011).

2.19. How important is alteration of ecosystem function (e.g. habitat change, nutrient cycling, trophic interactions), including losses to ecosystem services, caused by the organism likely to be in Europe in the future?	High	low	There is increasing evidence that invasive alien species can adversely affect the structure and functioning of aquatic ecosystems. Alternatively, a change in structure and functioning may also facilitate the introduction and spread of alien species. A reduction in native species richness – for example, caused by hydro morphological changes – may affect the resilience of communities to invasions, or eutrophication may dramatically alter the food-web structure in favor of non-native species. The latter is true for many shallow lakes, where increased nutrient levels have induced a shift from a top-down to a bottom-up regulated food web structure, with reduced control of invasive planktivorous and benthivorous fish. The effects of invasive alien species and other pressures are likely to reinforce each other, potentially resulting in an invasional meltdown at the water body level. At the regional scale, positive feedback mechanisms might explain the observed exponential increase in the numbers of alien species (Vandekerkhove *et al*., 2013). In the some way, the changes in ecosystem functions are expected to grow in the future where *L. gibbosus* is present.
2.20. How important is decline in conservation status (e.g. sites of nature conservation value, WFD classification) caused by the organism currently in Europe?	moderate	medium	*L. gibbosus* is known as successful invader in human-altered water bodies and water courses, but remains a background species in natural systems. This species has been introduced in many natural parks. As explained above, the species is also held responsible for the locally strong decline and disappearance of endangered amphibians, gastropods and dragonflies including several species listed in the Council Directive 92/43/EEC (Habitats Directive).

			There is no reason to expect that an abundance of *L. gibbosus* would negatively impact a potable water supply. However as *L. gibbosus* can lead to reduced species diversity at invaded sites, this could have implications for scoring of water quality using biological metrics and have implications for the Water Framework Directive.
2.21. How important is decline in conservation status (e.g. sites of nature conservation value, WFD classification) caused by the organism likely to be in the future in Europe?	moderate	low	If the spreads continues, more species could suffer because of this organism. The information provided by the risks assessments carried out in Europe demonstrated a medium or high risk for invasion in most of the ecosystems where undertaken (See Q.3 in Section A). Gkenas *et al*. (2016) found that in the case of *L. gibbosus*, trophic patterns reflected the consumption of a higher diversity of preys confirming that plasticity may persist along the invasion process. The loss of biodiversity and quality of the ecosystems supposes a decline of the nature conservation value which is expected to become poorer in the future in these areas where biodiversity loss could be important.
2.22. How important is it that genetic traits of the organism could be carried to other species, modifying their genetic nature and making their economic, environmental or social effects more serious?	minimal	medium	There is no evidence of possibility of hybridisation with native species but hybridisation within species of the same family occurs, making more difficult to distinguish between species (Misra and Holdsworth, 1972).
2.23. How important is social, human health or other harm (not directly included in economic and environmental categories) caused by the organism within its existing geographic range?	low	medium	*L. gibbosus* has long been considered a pest but there is no documented evidence of the species having an adverse effect other than public perception. Today is perceived more like an annoyance for the anglers and can lower the economic value of a reservoir.

2.24. How important is the impact of the organism as food, a host, a symbiont or a vector for other damaging organisms (e.g. diseases)?	moderate	medium	Three groups of parasites infesting the gills of *L. gibbosus* were described by Hanek and Fernando (1978): Monogenea, glochidia of *L. radiate* and Copepoda. Anseeuw *et al*. (2011) described also this species as hosting non-native parasites. Hockley *et al*. (2011) detected a non-native parasite on introduced *L. gibbosus*, which was not found on native species within the waterbody. More information about this kind of impact is not available.
2.25. How important might other impacts not already covered by previous questions be resulting from introduction of the organism? (specify in the comment box)	NA		
2.26. How important are the expected impacts of the organism despite any natural control by other organisms, such as predators, parasites or pathogens that may already be present in Europe?	moderate	medium	Despite of any predators, parasites and pathogens present in Europe, *L. gibbosus* had a very successful invasion history in most part of Europe as described previously. The largemouth bass (*Micropterus salmoides*), native to North America, is an important predator of this species, but also of native species in Europe, so it should not be used for biocontrol. Native predatory species within the introduced range of *Lepomis gibbosus* could be used to control populations (c.f. Davies and Britton, 2015) and reduce impacts.
2.27. Indicate any parts of Europe where economic, environmental and social impacts are particularly likely to occur (provide as much detail as possible).	[central and southern areas of Europe; Continental	medium	The European areas such as Mediterranean, Atlantic, Alpine, Black Sea, Continental, Steppic and Pannonian are the most prone to receive negative environmental

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<td>Mediterranean, Alpine, Atlantic, Black Sea, Pannonian, Steppic biogeografical regions]</td>
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<td>impacts, as freshwater fauna is commonly high in endemism and it is very threatened.

As it can be seen in the map below (which reflects the climate similitude between the area of origin and Europe) a wide European area could be particularly affected by this species (Climatch, 2018).

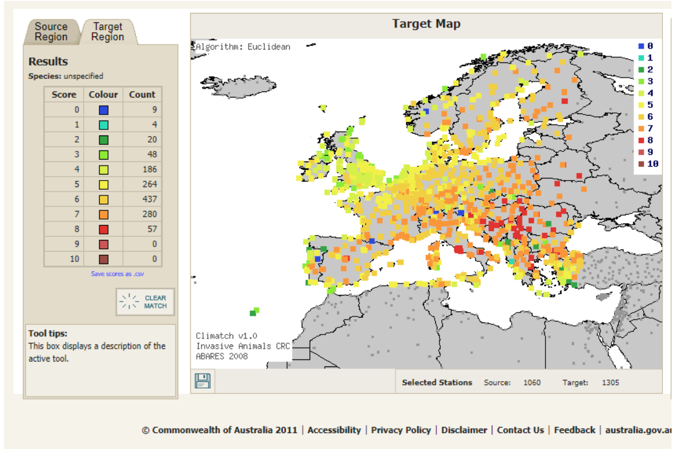
The Nordic countries of the EU could be threatened by the possible expansion of this species in a climate change scenario.


Figure 2. Map showing the areas that could be particularly affected by L. gibbosus (Climatch, 2018)</td>
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RISK SUMMARIES			
	RESPONSE	**CONFIDENCE**	**COMMENT**
Summarise Entry	likely	medium	*Lepomis gibbosus* is already widely introduced in Europe but introduction pathways are still open, suggesting further entries are likely. Due to disease controls and license requirements the demand and the ornamental and pet trade for *L. gibbosus* decreased. Still there is evidence of trade in Europe where pumpkinseed is imported for ornamental purpose in shops and also by internet (Van der Valk *et al*., 2018). While these restrictions may reduce the risk of new introductions they do not eliminate the risk entirely. It is expected that *L. gibbosus* will still be introduced to new reservoirs by human assistance (e.g. by anglers), which appears to remain an usual practice in some parts of Europe.
Summarise Establishment	very likely	high	*Lepomis gibbosus* is established in 24 EU countries. These are: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, France, Finland, Germany, Greece, Hungary, Italy, Latvia, Lithuania, Luxembourg, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, UK. In northern Europe the species is established almost exclusively in lacustrine ecosystems, in southern latitudes, in particular in Iberia, *L. gibbosus* populations establish easily in regulated rivers and reservoirs. Anyway a large area in Europe is subject to establishment (Figure 2)

			Under conditions of climate change, the establishment of new populations is to be expected.
Summarise Spread	moderately	high	In the past, spread of pumpkinseed was mainly supported by human assistance. Nowadays spread happens mainly by natural means but human assistance is also an habitual practice. As the species has already established in Europe it is likely that further dispersal will occur, predominantly from lentic waterbodies with direct hydrological connection to rivers and streams or those within a floodplain. Once established the organism could easily spread to a suitable habitat giving its characteristics of survivors. Life-history traits and the absence of congeneric competitors helped *L. gibbosus* to easily spread in almost all Europe. Future climate change scenarios are likely to increase the chance of spread, with elevated flows and frequency expected to contribute to dispersal of *L. gibbosus* from hydrologically connected sites, increasing propagule pressure on the receiving environments.
Summarise Impact	moderate	medium	*Lepomis gibbosus* is a successful invader in Europe, where it has caused negative ecological effects either direct predation or through cascading indirect effects through different trophic levels. Many authors cited the adverse impact of *L. gibbosus* on other species (Welcomme (1988); Wainwright *et. al*. (1991) García-Berthou and Moreno-Amich (2000),

			Janssen (2000), Casal (2006), Tomoček *et al*. (2007); van Kleef *et al*. (2008), Bosman (2003), Soes (2011)). *Lepomis gibbosus*, as well as other introduced species, actively prey on vulnerable native species of great conservation interest in Spain and Portugal as: *Anaecypris hispanica, Salaria fluviatilis, Aphanius iberus, Luciobarbus guiraonis, Luciobarbus haasi, Luciobarbus comizo*, *Chondrostoma lemmingii, Chondrostoma miegii, Gobio gobio, Squalius cephalus, Squalius pyrenaicus, Cobitis paludica, Valencia hispanica* (Blanco-Garrido *et al,* 2009, Elvira, 1997; Doadrio, 2002). The species is held responsible for the locally strong decline and disappearance of endangered species like amphibians (Bosman, 2003; Soes, 2011), gastropods (Wainwright *et. al*, 1991) and dragonflies (Janssen, 2000) and also resulted in a destabilizing process of *Littorella uniflora* plants, an endangered species in the Netherlands (Soes *et al*., 2011). In the Black Lists for Germany and Austria, the species was assessed as potentially invasive (Wiesner *et al*. 2010, Nehring *et al*. 2015). As mentioned before, trophic interactions and alterations in abiotic conditions of reservoirs can lead to a negative impact of pumpkinseed on ecosystem function (Gkenas *et al*., 2016). In Europe the organism is present in 25 Member States and established in 24 Member States, in nine of them is already considered invasive. As mentioned in Q.3

			Section A, several risk screenings of non-native freshwater fishes assessed pumpkinseed with a risk of invasiveness of medium high or high. In change in Great Britain (Oreska and Aldridge, 2011) (See Q.8 – Section A for details) it wasn´t considered as very likely to cause economic impacts. The economic impacts of *Lepomis* spp. wasn´t quantified in its introduced range. In general the economic impact is unknown because of a lack of studies. Economic impacts are often difficult to assess and to quantify, further studies should be developed in order to quantify economic loss. Prevention through public education and banning these species from trade is key to minimise those impacts. There are no studies regarding the economic costs of the establishment of *Lepomis gibbosus* in Europe but loss of biodiversity, impacts on native species and threats to ecosystem function occurred and are expected to grow.
Conclusion of the risk assessment	moderate	medium	Further dispersal, including by anthropogenic means, is very likely. Coupled with the plasticity of *Lepomis gibbosus* life-history traits and environmental tolerances, increased impacts on ecosystem function and native biota are expected. The effect of climate change will encourage their further expansion. The prevention of entries and further spread are the main measures to avoid future impact. The major components of such prevention are banning potential invasive species from trade and educating the public about when such

			centrarchids are actually obtained for e.g. aquaria, garden ponds or fish ponds (Soes *et al*, 2011).
ADDITIONAL QUESTIONS - CLIMATE CHANGE			
3.1. What aspects of climate change, if any, are most likely to affect the risk assessment for this organism?	[Temperature rise]	high	Predictions of future climate change include shifts in patterns of precipitation, evapotranspiration and water run-off, resulting in increased periods of drought as well as variability and intensity of rainfall events (Fobert *et al*., 2013). Although there are a number of factors that influence the invasion potential for a given species, water temperature is certainly one of the most important in inland waters for fish species. Water temperatures have been cited as regulating the distribution of warmwater fishes such as centrarchids. As air temperatures increase with climate change, the thermal habitat of most northern waterbodies lakes would become suitable for warmwater fish habitation (Magnuson et al., 1979; Stasko *et al*., 2012). There is also the possibility that populations of centrarchid fishes would be able to expand their distributions further north (Soes *et al*, 2011). Other life-history characteristics (e.g. mortality rate, plasticity, reproductive strategy) are also likely to affect invasiveness (Olden *et al*., 2006). Extreme hydrological events (floods, spates) such as predicted for future climatic conditions could enable *L. gibbosus* to establish new pond populations readily (Fobert *et al*., 2013). So it is to expect that climate change will help the future spread of this species (Copp *et al.* 2009; Britton *et al.* 2010; Zieba *et al.* 2015).

			Whilst not currently considered to be invasive at more northerly latitudes, including the UK, at least *L. gibbosus* is predicted to become invasive under conditions of climate warming (Britton *et al*., 2010); this is expected to result in earlier reproduction (Zieba *et al*., 2010), enhanced recruitment (Zieba *et al*., 2015) and subsequent greater dispersal (Fobert *et al.* 2013). These traits are then anticipated to result in adverse impacts on native species and ecosystems (e.g. Angeler *et al*., 2002; Van Kleef *et al*., 2008).
3.2. What is the likely timeframe for such changes?	20 years	medium	For the next two decades, a warming of about 0.2°C per decade is projected for a range of different emission scenarios. Even if the concentrations of all greenhouse gases and aerosols had been kept constant at year 2000 levels, a further warming of about 0.1°C per decade would be expected (IPCC Fourth Assessment Report: Climate Change 2007). Some climate change signal is found in sea level pressure in the winter season with lower pressure in the Northeast, but the signal is not very robust. This is however consistent with the temperature and precipitation changes and suggests expansion of the subtropical dry zone into Southern Europe and an enhanced hydrological cycle in Northern Europe and Scandinavia (Vautard *et al*, 2014).
3.3. What aspects of the risk assessment are most likely to change as a result of climate change?	[Establishment, spread and invasiveness]	medium	Fobert *et al.* (2013) examined how hydrological variability induced by predicted changes in climate will affect the dispersal and spread of pumpkinseed in England by: (i) determining the relationship between discharge regime and pumpkinseed propagule pressure; (ii) examining a newly-established pumpkinseed population following a flood event in 2007; and (iii) comparing the growth and life-history traits of this new

			population with fish collected from the source population to demonstrate how the pumpkinseed's life-history plasticity contributes to its success as a coloniser. In conclusion, although pumpkinseed are not currently considered invasive in the United Kingdom, the pumpkinseed's status in the United Kingdom is likely to shift to invasive under predicted future conditions (Fobert *et al*, 2013). With increased survival and recruitment under conditions of a warmer climate, and life history traits that enable colonisation and establishment in novel environments, the pumpkinseed will be able to exploit the increased hydrological variability and the extensive connectivity of canals and water course in southern England to expand its introduced range. Management strategies will be required to mitigate the impacts of pumpkinseed on the native species and ecosystems and should include control and containment initiatives to enhance outflow systems to control fish escapement (Britton *et al*. 2010). Spread of *L. gibbosus* propagules in hydrologically connected waterbodies has been demonstrated and it is likely to increase under climate change scenarios (Fobert *et al*, 2013). All these stages of the invasion process are highly influenced by temperature in ectothermic species.
ADDITIONAL QUESTIONS - RESEARCH			
4.1. If there is any research that would significantly strengthen confidence in the risk assessment please summarise this here.	[The impact to native fauna should be further investigated]	medium	Further research on the impact of the organism within different countries and environments (lentic and lotic) of their invaded range would be recommended.

			Dietary analysis would reveal the degree of competition with native fish species and likelihood of native species displacement/ predation by *Lepomis*. Additionally, species-specific control measures should be identified, where possible and mechanisms of *Lepomis* species control/ extirpation investigated. The impact (especially economic) of *L. gibbosus* in Europe remains poorly assessed.

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