Risk Assessment of *Cyprinus carpio*

Name of Organism:	*Cyprinus carpio* Linnaeus 1758 – Common Carp
Objective:	Assess the risks associated with this species in Ireland
Version:	Final 15/09/2014
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Expert reviewer	Lorenzo Vilizzi

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About the risk assessment

This risk assessment is based on the **N**on-native species **AP**plication based **R**isk **A**nalysis (NAPRA) tool (version 2.66). NAPRA is a computer based tool for undertaking risk assessment of any non-native species. It was developed by the European and Mediterranean Plant Protection Organisation (EPPO) and adapted for Ireland and Northern Ireland by Invasive Species Ireland. It is based on the Computer Aided Pest Risk Analysis (CAPRA) software package which is a similar tool used by EPPO for risk assessment.

Notes: Confidence is rated as low, medium, high or very high.
Likelihood is rated as very unlikely, unlikely, moderately likely, likely or very likely.
The percentage categories are 0% - 10%, 11% - 33%, 34% - 67%, 68% - 90% or 91% - 100%.
N/A = not applicable.

This is a joint project by Inland Fisheries Ireland and the National Biodiversity Data Centre to inform risk assessments of non-native species for the European Communities (Birds and Natural Habitats) Regulations 2011. It is supported by the National Parks and Wildlife Service.

DOCUMENT CONTROL SHEET

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Version Control Table

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Stage 1 - Organism Information *The aim of this section is to gather basic information about the organism.*			
N	**QUESTION**	**RESPONSE**	**COMMENT**
1	What is the reason for performing the risk assessment?		A risk assessment is required as this species is listed as a "Non-native species subject to restrictions under Regulations 49 and 50" in the Third Schedule of the European Communities (Birds and Natural Habitats) Regulations 2011, SI 477/2011.
2	Identify the organism. Is it clearly a single taxonomic entity and can it be adequately distinguished from other entities of the same rank?	YES	Scientific names (after Global Invasive Species Database 2010): *Cyprinus carpio* Linnaeus, 1758 [valid: see below]; *Carpio carpio gibbosus* Kessler, 1856; *Carpio flavipinna* Valenciennes, 1842; *Carpio vulgaris* Rapp, 1854; *Cyprinus acuminatus* Heckel & Kner, 1858; *Cyprinus acuminatus* Richardson, 1846; *Cyprinus angulatus* Heckel, 1843; *Cyprinus atrovirens* Richardson, 1846; *Cyprinus bithynicus* Richardson, 1857; *Cyprinus carpio anatolicus* Hanko 1924 *Cyprinus carpio aralensis* Spiczakow, 1935; *Cyprinus carpio brevicirri* Misik, 1958; *Cyprinus carpio elongatus* Walecki 1863; *Cyprinus carpio fluviatilis* Pravdin, 1945; *Cyprinus carpio longicirri* Misik 1958; *Cyprinus carpio monstrosus* Walecki 1863; *Cyprinus carpio oblongus* Antipa, 1909; *Cyprinus chinensis* Basilewsky, 1855; *Cyprinus conirostris* Temminck & Schlegel, 1846; *Cyprinus festetitsii* Bonaparte, 1845; *Cyprinus flamm* Richardson, 1846; *Cyprinus fossicola* Richardson, 1846; *Cyprinus haematopterus* Temminck & Schlegel, 1846 [questioned: see below]; *Cyprinus melanotus* Temminck & Schlegel, 1846; *Cyprinus nordmannii* Valenciennes, 1842; *Cyprinus sculponeatus* Richardson, 1846; *Cyprinus thermalis* Heckel, 1843; *Cyprinus tossicole* Elera, 1895; *Cyprinus vittatus* Valenciennes, 1842. A more complete and up-to-date list of synonyms can be found in Fishbase (http://www.fishbase.org/Nomenclature/SynonymsList.php?ID=1450&SynCode=29900&GenusName=Cyprinus&SpeciesName=carpio). Also, the validity of the name *C. c. haematopterus* (the eastern dispersant: see Q7, below) is currently being questioned (Kottelat 2006), with the result that the following two species may be valid within the *C. carpio* complex, namely *C. carpio* (or *C. c. carpio*, the western dispersant: see Q7, below) and *C. rubrofuscus* (the eastern dispersant), the latter with a possibly misapplied name as *C. haematopterus* (or *C. c. haematopterus*), which is still widely used in the literature (Nicolas Bailly, FishBase WorldFish FIN/ABIO, pers. comm.). Common names (after Global Invasive Species Database 2010): • Carp (currently, less used relative to Common carp as 'too generic' a name, i.e. it may refer to other species in the carp group); • Common carp (the most widely accepted and used name in the literature); • European carp (obsolete);

Stage 1 - Organism Information *The aim of this section is to gather basic information about the organism.*			
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			• Fancy carp (very uncommon); • Feral carp (to be used only with comparison to domesticated or wild = native forms); • German carp (obsolete); • Grass carp (incorrect, being the common name for *Ctenopharyngodon idella*); • Japanese domesticated carp (very uncommon); • King carp (very uncommon); • Koi (refers to ornamental (coloured) varieties); • Koi carp (refers to ornamental (coloured) varieties, though tautological: i.e. koi = carp); • Leather carp (to be used only with reference to scalation variants: see Q4 below); • Linear carp (actually, 'line carp', to be used only with reference to scalation variants: see Q4 below); • Mirror carp (to be used only with reference to scalation variants: see Q4 below); • Naked carp (same as 'Leather carp', to be used only with reference to scalation variants: see Q4 below); • Nude carp [uncommon, likely a synonym for naked, to be used only with reference to scalation variants: see Q4 below); • Oriental carp (very uncommon and overall incorrect given the Aral, Caspian and Black Sea origin of the species: cf. Balon 1995); • Scale carp (more appropriately 'Scaled carp', to be used only with reference to scalation variants: see Q4 below); • Scattered carp [refers to a variety of mirror carp (Balon 1995) and is to be used only with reference to scalation variants] • Wild carp [the native common carp].
3	If not a single taxonomic entity, can it be redefined? (if necessary use the response box to re-define the organism and carry on)	N/A	There are numerous strains of *C. carpio* (see above), with 30–35 strains of the domesticated form present in Europe alone (FAO 2004).
4	Describe the organism.		*C. carpio* are variable in form, proportions, colour, fins and squamation. They can weigh up to 60 kg and grow up to 120 cm in (standard) length (www.fishbase.org). In the wild, they are usually of less stocky build than ornamental strains with a height of body to length ratio of 1:3.2 to 4.8, and they are typically olive green to bronze or silvery in colour with a paler underside (Balon 1995). The ornamental koi strain is brightly coloured with orange, yellow, white and black markings

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N	**QUESTION**	**RESPONSE**	**COMMENT**
			(Axelrod 1988; Balon 2004). *C. carpio* have thick lips and two barbels at each inferior corner of the mouth. The tail-fin is forked. The dorsal fin is long with 17–23 rays and 3–4 spines. The anal fin has 5–6 rays and 2–3 spines. The caudal fin has 17–19 rays and 3 spines (Balon 1995). Squamation is variable between varieties (Balon 1995; Kirpitchnikov 1999). These include the fully-scaled (or scaled) common carp; the mirror carp, which has some greatly enlarged and shining scales (sometimes in rows or haphazardly distributed) on an otherwise naked body; the leather or naked carp, with a thick skin and only a few scales or none; the line carp, with a regular single row of scales along the centre of its sides; and a leaden-coloured form, which appears naked, but has a full covering of very thin scales devoid of pigment (see also Global Invasive Species Database 2010; Inland Fisheries Ireland 2013).
5	Does a relevant earlier risk assessment exist? (give details of any previous risk assessment)	YES	A risk assessment using the FISK tool (Freshwater Fish Invasiveness Scoring Kit: Copp *et al.* 2005) indicated that *C. carpio* was "highly invasive in Ireland" (Macklin *et al*. 2013). "Please note that although the FISK tool indicated that *C. carpio* was 'highly invasive' in Ireland, this may not be the case. Currently there is a lack of sufficient scientific data and evidence to confirm whether or not the species exhibits highly invasive characteristics in Irish waters. In fact, available knowledge and data would, if anything, suggest that the species does not display typical invasive characteristics in Ireland, with it being largely reliant on anthropogenic movements and stockings in order to persist in the wild. These points are discussed in Macklin *et al*. (in press). This contextualisation is vital for such a risk assessment." (Bill Brazier, UCC, personal communication).
6	If there is an earlier risk assessment is it still entirely valid, or only partly valid?	PARTLY VALID	The FISK risk assessment (Macklin *et al*. 2013) is not available to review as part of this risk assessment, as it will be subject to publication.
7	Where is the organism native?		The wild ancestor of *C. carpio* originated in the Aral, Black and Caspian sea drainage basins and dispersed east into Siberia and China (eastern dispersant: *C. c. haematopterus* or *C. rubrofuscus*: see above Q2), and west as far as the Piedmont zone of the River Danube (western dispersant: *C. carpio* or *C. c. carpio*) (Balon 1995).
8	What is the current global distribution of the organism (excluding Ireland)?		*C. carpio* has a worldwide distribution, excluding the polar regions (Naylor *et al*. 2000; Bakos 2001). It is currently established in 91 of 120 countries of introduction worldwide (Welcomme 1988; Casal 2006).

Stage 1 - Organism Information *The aim of this section is to gather basic information about the organism.*			
N	**QUESTION**	**RESPONSE**	**COMMENT**
9	What is the current distribution of the organism in Ireland?		*C. carpio* is locally distributed in Ireland. It is largely confined to landlocked lakes or ponds, but is also present in small quantity in larger Irish waterbodies and watercourses including Inniscarra Reservoir, the Grand and Royal canals, River Barrow and River Shannon (Inland Fisheries Ireland 2013). In Ireland it is recorded in a total of 98 10km squares (Macklin and Brazier 2011, unpublished). There have been numerous introductions of *C. carpio* to Irish waters since the 17th century. However, in the majority of cases self-sustaining populations did not establish due to an inability to reproduce or due to local changes in environmental conditions (e.g. drying up of ponds) (Brazier *et al.* 2012).
10	Is the organism known to be invasive anywhere in the world?	YES	"On every continent where it has been introduced it has reduced water quality and degraded aquatic habitats" (reviewed in Global Invasive Species Database 2010). *C. carpio* is regarded as a highly invasive and noxious species in North America (Weber and Brown 2009) and Australia (Koehn 2004), but with recent projections indicating a high risk of further spread across these and other continents (Koehn 2004; Zambrano *et al.* 2006). However, even in 'naturalised' areas of introduction (*sensu* Copp *et al.* 2005) such as western Europe and the Mediterranean Region, there has been increased awareness of potential impacts to the aquatic ecosystem which has recently encouraged a re-assessment of the species' status and associated risks of invasiveness (Vilizzi 2012; Almeida *et al.* 2013; Puntila *et al.* 2013; Tarkan *et al.* 2014).

Stage 2 - Detailed assessment: Section A - Entry

This section evaluates the probability of entry of an organism into Ireland. For organisms which are already present, only complete the entry section for currently active pathways of entry and potential future pathways. The entry section need not be completed for pathways which have allowed an organism to enter in the past but are no longer active.

N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
1.01	How many active/future pathways are relevant to the potential entry of this organism (n/a, very few, few, moderate number, many or very many)?	Moderate	VERY HIGH	Fish stocking for angling; ornamental trade; live bait for angling.
1.02	List significant pathways through which the organism could enter. Where possible give detail about the specific origins and end points of the pathways.	1. Fish stocking for angling 2. Ornamental trade 2. Live bait for angling.		*C. carpio* has been imported into Ireland to stock both private and public fisheries for angling or ornamental purposes (and as a lesser extent for food) since the 17th Century (Brazier *et al.* 2012). In Ireland, this practice is now largely governed by European Communities (Health of aquaculture animals and products) Regulations 2008 (S.I. 261 of 2008) based on the European Commission's Council Directive 2006/88//EC applies to the import, movement, sale and supply of aquatic animals for fish stocking or ornamental purposes. Under the regulations, where appropriate, notification of the import and movement of fish must be made to the Marine Institute and this must be accompanied by an appropriate health certificate stating that the animal is free of the diseases listed in Part II Annex IV of the Directive and diseases for which Ireland has national measures granted under Commission Decision 2010/221/EU. Illegal introductions of *C. carpio* stocks for angling have also occurred in recent times (Brazier *et al.* 2012). There have been reports of fish being illegally used as live bait for angling (Shannon Regional Fisheries Board 2009) and attempted illegal imports for such use. In addition to the import and stocking of *C. carpio* for angling purposes, ornamental varieties (particularly, koi) are commonly imported into Ireland *via* the ornamental trade for sale in aquarium and pet shops to stock in ornamental ponds and aquaria.

Pathway 1 - Fish stocking for angling				
N	**QUESTION**	**RESPONSE**	**CONFIDENCE**	**JUSTIFICATION**
1.03	Is entry along this pathway intentional (e.g. the organism is imported for trade) or accidental (e.g. the organism is a contaminant of imported goods)?	INTENTIONAL	VERY HIGH	*C. carpio* is deliberately imported *via* the fish stocking trade for angling purposes.
1.04	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?	VERY LIKELY	VERY HIGH	Recent official imports (since 2008) have largely been sourced from a single reputable supplier in England, with the agreement of the Marine Institute, for recreational angling purposes. These fish are typically stocked, following agreement with Inland Fisheries Ireland (IFI) or its predecessor, into a small number of designated private fisheries throughout Ireland. In compliance with IFI guidance on *C. carpio* stocking, these fish are only introduced into landlocked waters either known to contain the species (designated 'carp waters') or artificial landlocked waters where the possible ecological impact of *C. carpio* would be minimal and limited to that specific location (Brazier *et al*. 2012).
1.05	How likely is the organism to enter Ireland undetected or without the knowledge of relevant competent authorities?	LIKELY	VERY HIGH	It is likely that consignments of *C. carpio* imported *via* the fish stocking trade for angling purposes can enter Ireland undetected or without the knowledge of the relevant and competent authorities, despite the official regulations in place for importation (refer to response to Question 1.02). This is highlighted by the illegal importation into Ireland of 2.2 tonnes of *C. carpio* in 2003 sourced from a supplier in France for stocking purposes (Brazier *et al*. 2012).
1.06	How likely is the organism to survive during passage along the pathway?	VERY LIKELY	VERY HIGH	As the organism is deliberately distributed *via* the fish stocking trade for angling purposes and transported in an aquatic environment, survival is highly likely.
1.07	How likely is the organism to arrive during the months of the year appropriate for establishment?	VERY LIKELY	VERY HIGH	There is no known seasonal restriction to inhibit the establishment of *C. carpio* stocked for angling purposes after introduction to a water. Self-sustaining (i.e. reproducing) populations are not commonplace (but do exist) in Ireland as water temperatures (< 18^{o}C) are generally inadequate for spawning (Brazier *et al*. 2012; Inland Fisheries Ireland 2013). However, it should be noted that *C. carpio* have been observed to spawn in south-eastern Australia in water temperature as low as 15 ^{o}C (Smith and Walker 2004a,b; Tempero *et al*. 2006; Vilizzi 2012). Also, the species can live for up to 47 years in captivity (Carey and Judge 2000), but a life-span of 13–20 years is more typical in the wild (Chumchal 2002; Vilizzi *et al*. 2014a). However, recent findings from North American cold waters suggest life spans of up to 30 years (Andrew L. Rypel, Washington University in St. Louis, pers. comm.).

Pathway 1 - Fish stocking for angling				
N	**QUESTION**	**RESPONSE**	**CONFIDENCE**	**JUSTIFICATION**
1.08	How likely is the organism to be able to transfer from the pathway to a suitable habitat or host?	VERY LIKELY	VERY HIGH	In Ireland there is an abundance of suitable waters, which are stocked for angling purposes, for *C. carpio* to establish in. The species is most suited to soft-bottomed, well-vegetated, slow-flowing or static lowland waters (Inland Fisheries Ireland 2013). In the majority of cases, *C. carpio* that are to be used for angling purposes are stocked into landlocked lakes or ponds. However, some stocking has occurred in waters proximal or linked to natural systems (Brazier *et al.* 2012), which increases the likelihood of it transferring from this pathway to a suitable wild habitat.
1.09	Estimate the overall likelihood of entry into Ireland based on this pathway?	VERY LIKELY	VERY HIGH	It is already deliberately imported *via* fish stocking trade for angling purposes and may also be brought in illegally by anglers for stocking.
1.10	Do other pathways need to be considered?	YES		See below Pathways 2 (Ornamental trade) and 3 (Live bait for angling).

Pathway 2 - Ornamental trade				
N	**QUESTION**	**RESPONSE**	**CONFIDENCE**	**JUSTIFICATION**
1.03	Is entry along this pathway intentional (e.g. the organism is imported for trade) or accidental (e.g. the organism is a contaminant of imported goods)?	INTENTIONAL	VERY HIGH	Ornamental *C. carpio* (the majority of which are of the koi variety) are deliberately imported *via* the ornamental trade for sale in aquarium and pet shops to stock in ornamental ponds and aquaria. They are also imported for direct sale to individuals, such as hobbyists, *via* internet purchases. They are widely kept in Ireland.
1.04	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?	VERY LIKELY	VERY HIGH	Large numbers of ornamental *C. carpio* enter *via* this pathway each year and are widely available for purchase in Ireland or directly from abroad, as outlined above.
1.05	How likely is the organism to enter Ireland undetected or without the knowledge of relevant competent authorities?	LIKELY	VERY HIGH	It is likely that consignment of ornamental *C. carpio* can enter Ireland undetected or without the knowledge of the relevant and competent authorities. However, it should be noted that official imports are subject to strict regulations to prevent the spread of disease (http://www.fishhealth.ie/FHU/MovingFish/ImportingOrnamentalFish/).

Pathway 2 - Ornamental trade				
N	**QUESTION**	**RESPONSE**	**CONFIDENCE**	**JUSTIFICATION**
1.06	How likely is the organism to survive during passage along the pathway?	VERY LIKELY	VERY HIGH	As the organism is deliberately distributed *via* trade and transported in an aquatic environment, survival is highly likely.
1.07	How likely is the organism to arrive during the months of the year appropriate for establishment?	VERY LIKELY	VERY HIGH	There is no known seasonal restriction to inhibit the establishment of ornamental *C. carpio* after introduction to a water. Self-sustaining (i.e. reproducing) populations are unknown in Ireland but ornamental *C. carpio* are established in numerous confined waters in this country, notably private ponds and aquaria. For example, in New Zealand feral koi have been known to spawn at water temperatures as low as 16.5 ^{o}C (Tempero *et al*. 2006). However, in general, water temperatures in Ireland (<18 ^{o}C) are considered inadequate for *C. carpio* spawning (Brazier *et al*. 2012; Inland Fisheries Ireland 2013).
1.08	How likely is the organism to be able to transfer from the pathway to a suitable habitat or host?	UNLIKELY	VERY HIGH	In Ireland there is an abundance of suitable waters for ornamental *C. carpio* to establish in. These varieties are most suited to soft-bottomed, well vegetated, slow-flowing or static lowland waters (Inland Fisheries Ireland 2013). In Ireland, ornamental *C. carpio* are stocked into confined waters, notably small private ponds or aquaria where the risk of natural escape is highly unlikely. The sole means where ornamental *C. carpio* could transfer from this pathway to a suitable aquatic habitat in the wild is *via* human-mediated introductions.
1.09	Estimate the overall likelihood of entry into Ireland based on this pathway?	LIKELY	VERY HIGH	Ornamental *C. carpio* are already imported into Ireland *via* the ornamental trade. The principal potential means of transfer to suitable aquatic habitats in the wild is *via* human introductions.
1.10	Do other pathways need to be considered?	YES		See below Pathway 3 (Live bait for angling).

Pathway 3 – Live bait for angling.				
N	**QUESTION**	**RESPONSE**	**CONFIDENCE**	**JUSTIFICATION**
1.03	Is entry along this pathway intentional (e.g. the organism is imported for trade) or accidental (e.g. the organism is a contaminant of imported goods)?	INTENTIONAL	VERY HIGH	See below.
1.04	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?	UNLIKELY	Medium	Only one documented instance has occurred in recent times where live *C. carpio* from France were used as bait for pike (*Esox lucius* L.) fishing in Lough Derg (Shannon Regional Fisheries Board 2009). From anecdotal accounts, it is suspected other such instances have occurred in recent years, including an angler who attempted to import illegally live *C. carpio* from Britain for use as bait. It is considered unlikely that ornamental varieties, such as koi, have been regularly used as live bait in Ireland.
1.05	How likely is the organism to enter Ireland undetected or without the knowledge of relevant competent authorities?	VERY LIKELY	VERY HIGH	It is very likely *C. carpio* can enter Ireland undetected or without the knowledge of the relevant and competent authorities as such live bait would likely be concealed by an angler during transit.
1.06	How likely is the organism to survive during passage along the pathway?	VERY LIKELY	VERY HIGH	The intention would be to keep the fish alive during transit for subsequent use as live bait for angling.
1.07	How likely is the organism to arrive during the months of the year appropriate for establishment?	LIKELY	HIGH	Refer to Question 1.07 (Pathway 1).
1.08	How likely is the organism to be able to transfer from the pathway to a suitable habitat or host?	VERY LIKELY	VERY HIGH	In Ireland there is an abundance of suitable waters for *C. carpio* to establish in. The species is most suited to soft-bottomed, well vegetated, slow-flowing or static lowland waters (Inland Fisheries Ireland 2013). In addition, there is the potential for the escape of live bait while being used, as well as the dumping of live bait into a recipient water after the conclusion of an angling excursion.
1.09	Estimate the overall likelihood of entry into Ireland based on this pathway?	MODERATELY LIKELY	HIGH	This pathway depends on the illicit movement of *C. carpio* for use as live bait into Ireland from abroad. Only a single documented record exists (Shannon Regional Fisheries Board 2009), although anecdotal reports suggest this practice occurs occasionally.
1.10	Do other pathways need to be considered?	NO		

Overall likelihood				
N	**QUESTION**	**RESPONSE**	**CONFIDENCE**	**JUSTIFICATION**
1.11	Estimate the overall likelihood of entry into Ireland based on all pathways (comment on the key issues that lead to this conclusion).	VERY LIKELY	VERY HIGH	The primary pathway of entry of *C. carpio* into Ireland is through the fish stocking trade for angling purposes and the ornamental trade.

Stage 2 - Detailed assessment: Section B - Establishment

This section evaluates the probability of establishment of an organism within Ireland. For organisms which are already well established in Ireland there is no need to complete this section - move straight to the Spread section.

N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
2.01	Is the organism well established in Ireland (if there is any uncertainty answer 'unsure')	YES	VERY HIGH	*C. carpio* is locally distributed in Ireland. It is largely confined to landlocked lakes or ponds, but is also present in the Grand and Royal canals, River Barrow and River Shannon (Inland Fisheries Ireland 2013). In Ireland, it is recorded in a total of 98 10km squares (Macklin and Brazier 2011, unpublished). There have been numerous introductions of *C. carpio* to Irish waters since the 17th century. However, in the majority of cases self-sustaining populations did not establish due to an inability to reproduce or due to local changes in environmental conditions (e.g. drying up of ponds) (Brazier *et al.* 2012). Ornamental *C. carpio* (including koi) are largely confined to aquaria and private ponds, though there is evidence of individual specimens of koi living in sections of the Grand Canal (Circular Line) and Royal Canal (Mullingar) and in other natural watercourses. These instances, however, are exceptional in Ireland.
2.02	How likely is it that the organism will be able to establish in Ireland based on the similarity between local climatic conditions and the organism's current global distribution?	VERY LIKELY	VERY HIGH	Experience in Ireland shows that self-sustaining (i.e. reproducing) populations are not commonplace (but do exist) in Ireland as water temperatures (<18^{o}C) are generally inadequate for spawning (*Brazier et al.* 2012; Inland Fisheries Ireland 2013). The species can live for up to 47 years in captivity (Carey and Judge 2000), but a life-span of 13 - 20 years is more typical in the wild (Chumchal 2002). Because of climatic factors, the growth of *C. carpio* in Ireland is generally slower than other countries with higher annual mean temperatures than Ireland, although other factors may contribute to this including stocking density, local environmental conditions (e.g. water chemistry) and the limited genetic lineage of the stocked fish (Brazier *et al.* 2012*;* Inland Fisheries Ireland 2013). Ornamental *C. carpio* (koi) have a demonstrated ability to survive in both private outdoor ponds and in the limited number of external waters they have been introduced to in Ireland (refer to Question 2.01). However, such fish are unlikely to be fecund under Irish climatic conditions.

Stage 2 - Detailed assessment: Section B - Establishment

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N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
2.03	How likely is it that the organism will be able to establish in Ireland based on the similarity between other local abiotic conditions and the organism's current global distribution?	VERY LIKELY	VERY HIGH	There are likely no significant overriding abiotic factors present in Ireland to limit its further establishment. However, the establishment of self-sustaining reproducing populations in natural waters is limited (refer to Question 2.02 above).
2.04	How likely is the organism to encounter habitats necessary for the survival, development and multiplication of the organism in Ireland?	VERY LIKELY	VERY HIGH	In Ireland, there are an abundance of freshwater habitats (e.g. lakes, slow flowing rivers, ponds, canals and other artificial watercourses) suitable for the survival and development of the species. *C. carpio* stocked for angling are known to successfully reproduce and maintain self-sustaining populations in at least three waters in Ireland (Brazier *et al*. 2012), but these are believed to be the exception. In part, the low density of *C. carpio* in large natural or artificial waters may also substantially reduce fecundity in occasional years when water temperatures may suitable for spawning and thus prevent any long-term establishment of large populations (J. Caffrey pers. comm.). In addition, where single specimens are present at isolated locations (e.g. koi in the Grand Canal at Mullingar) there is obviously no potential for reproduction. Any capacity for reproduction is predicted to expand considerably if water temperatures rise as result of climatic change (J. Caffrey IFI pers. comm.). In general, the potential for *C. carpio* to disperse widely in open or semi-open (i.e. canals) systems once stocked is high.
2.05	How likely is it that establishment will occur despite competition from existing species in Ireland?	VERY LIKELY	VERY HIGH	Experience from stocked locations in Ireland demonstrates that adult *C. carpio* can establish and survive despite competition from existing species. However, it is suspected that predation by pike in a water stocked with juvenile carp may limit their survival and subsequent long-term establishment in some waters (J. Caffrey IFI pers. comm.; Weber and Brown 2012; Weber *et al.* 2012). Highly coloured ornamental carp, such as koi would be unlikely to establish in natural waters as they would be heavily preyed upon by sight-feeding piscivorous such as pike and perch (*Perca fluviatilis* L.).
2.06	How likely is it that establishment will occur despite predators, parasites or pathogens already present in Ireland?	VERY LIKELY	VERY HIGH	There are no known natural predators, parasites or pathogens of this species present in Ireland that will have an effect on its establishment. In 2005 and 2007, Koi Herpes Virus (KHV: Nica 2013) was detected in two respective batches of koi which had suffered mortalities after import to Ireland. In each case, molecular tests confirmed the presence of the

Stage 2 - Detailed assessment: Section B - Establishment

This section evaluates the probability of establishment of an organism within Ireland. For organisms which are already well established in Ireland there is no need to complete this section - move straight to the Spread section.

N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
				virus. However, secondary infections potentially arising from a reactivation of latent KHV were implicated in some of the fish deaths (McCleary *et al*. 2012). More recently (2011–2013), further concern was raised about KHV in angling common carp stocks. However, following exhaustive surveying by both the Marine Institute and IFI, which included that testing of specimens from *circa* 20 angling waters, no evidence of the virus was recorded (J. Caffrey pers. comm.).
2.07	How likely is it that establishment will occur despite existing management practices?	UNLIKELY	HIGH	*C. carpio* is already locally established in Ireland. The stocking, import, sale and supply of this species is largely governed by the European Commission's Council Directive 2006/88//EC and the movement of such fish by EU Water Framework Directive (Council Directive 2006/88/EC) as transcribed into Irish law (refer to Question 1.02). In Ireland, *C. carpio* stocking for angling purposes is managed to ensure there is minimal impact to native habitats and biodiversity. For example, the IFI stocking guidance is to introduce only such *C. carpio* into landlocked waters that are either known to contain the species (designated 'carp waters') or artificial landlocked waters where the possible ecological impact of *C. carpio* would be minimal and limited to that specific location (J. Caffrey, pers. comm. as cited in Brazier *et al*. 2012). Occasional illegal stocking from landlocked waters to natural systems do occur but it is rare that *C. carpio* establish with sufficient numbers to generate sustainable populations.
2.08	How likely is it that management practices in Ireland will facilitate the establishment of the organism?	UNLIKELY	HIGH	Refer to Question 2.07.
2.09	How likely is it that the biological characteristics of the organism would allow it to survive eradication campaigns in Ireland?	MODERATELY LIKELY	MEDIUM	Local eradication campaigns, if desired, are feasible (*via* dewatering, electrofishing or netting), particularly in landlocked or semi-open (e.g. canals) waters.
2.10	How likely is it that the biological characteristics of the organism will facilitate its establishment?	VERY LIKELY	VERY HIGH	Refer to Questions 2.02, 2.04 and 2.09.

Stage 2 - Detailed assessment: Section B - Establishment

This section evaluates the probability of establishment of an organism within Ireland. For organisms which are already well established in Ireland there is no need to complete this section - move straight to the Spread section.

N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
2.11	How likely is it that the organism's capacity to spread will facilitate its establishment?	MODERATELY LIKELY	VERY HIGH	Refer to Question 2.04.
2.12	How likely is it that the organism's adaptability will facilitate its establishment?	VERY LIKELY	VERY HIGH	*C. carpio* has a wide ecological tolerance which allows it to establish populations in a wide range of freshwater environments in Ireland (e.g. lakes, slow flowing rivers, ponds, canals and other artificial watercourses) (Balon 1995; Brazier *et al*. 2012). However, because of temperature requirements for successful spawning, the likelihood of producing sustainable populations is limited.
2.13	How likely is it that the organism could establish despite low genetic diversity in the founder population?	VERY LIKELY	VERY HIGH	*C. carpio* has already demonstrated its ability to establish despite apparent low genetic diversity in its founder populations (Brazier *et al*. 2012). However, introductions from multiple sources (e.g. England and France) in more recent times have been made, further promoting generic diversity.
2.14	Based on the history of invasion by this organism elsewhere in the world, how likely is it to establish in Ireland? If possible, specify the instances of invasion elsewhere in the justification box	VERY LIKELY	VERY HIGH	*C. carpio* already demonstrated this capacity in Ireland for fish stocked for angling purposes. There is only limited evidence available in Ireland to assess the establishment potential of ornamental varieties in the wild in Ireland and no sustainable populations have established under such circumstances to date. As stated previously, *C. carpio* has a very limited capacity to establish reproducing populations under current Irish climatic conditions.
2.15	If the organism does not establish, then how likely is it that transient populations will continue to occur?	VERY LIKELY	VERY HIGH	The continued deliberate stocking of long-lived *C. carpio* ensures this.
2.16	Estimate the overall likelihood of establishment. Mention any key issues in the comments box	VERY LIKELY	VERY HIGH	Refer to Questions 2.04, 2.10 and 2.12.

Stage 2 - Detailed assessment: Section C - Spread

This section evaluates the probability of spread of an organism within Ireland. Spread is defined as the expansion of the geographical distribution of an organism within the risk assessment area.

N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
3.01	What area (given in % or 10km squares) in Ireland could the organism establish (0% - 10%, 11% - 33%, 34% - 67%, 68% - 90% or 91% - 100%)?	34% - 67% of 10 km squares	VERY HIGH	*C. carpio* stocked for angling purposes has a wide ecological tolerance which allows it to establish populations in many freshwater environments in Ireland (refer to Question 2.04). This is uncertain for ornamental varieties (e.g. a heightened risk of predation) due to reasons outlined previously in this risk assessment.
3.02	How important is the expected spread of this organism in Ireland by natural means (minimal, minor, moderate, major or massive)?	MINIMAL	HIGH	Within connected systems, internal dispersal among fishes by natural movements occurs. Between catchments, there is a very low potential for natural spread, although it could be transferred *via* fertilised eggs attached to water fowl (Gilligan and Rayner 2007) and through flooding events creating a temporary pathway from isolated to open systems. The low recorded incidence of ornamental carp introductions suggests that natural spread will also be minimal in Ireland.
3.03	How important is the expected spread of this organism in Ireland by human assistance (minimal, minor, moderate, major or massive)?	MODERATE / MINOR	HIGH	As *C. carpio* continues to be deliberately traded, this greatly increases its potential for human-mediated spread. Illegal introductions and transfers have occurred for angling purposes and are likely to continue (Brazier *et al*. 2012). Ornamental carp are likely introduced to the wild solely through aquarium or private pond 'dumps'. As previously stated, such introductions have been exception to date. Therefore, their expected spread is considered to be minor.
3.04	Within Ireland, how difficult would it be to contain the organism (minimal, minor, moderate, major or massive)?	MODERATE	HIGH	*C. carpio* (stocked for angling purposes) are locally distributed in Ireland and there are relatively few naturally self-sustaining populations. It is largely confined to landlocked lakes or ponds, but is also present in the Grand and Royal canals, River Barrow and River Shannon (Inland Fisheries Ireland 2013). In Ireland it is recorded in a total of 98 x 10km squares (Macklin and Brazier 2011, unpublished). Therefore, containment is feasible if existing management practices continue to be upheld, there is continued buy-in from angling stakeholders and restrictions on its importation, transfer and sale are enforced.
3.05	What proportion (%) of the area in Ireland suitable for establishment, if any, has already been colonised by the organism?	0% -10%	VERY HIGH	Refer to Question 3.04.

Stage 2 - Detailed assessment: Section C - Spread

This section evaluates the probability of spread of an organism within Ireland. Spread is defined as the expansion of the geographical distribution of an organism within the risk assessment area.

N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
3.06	What proportion of the area in Ireland suitable for establishment, if any, do you expect to have been invaded by the organism five years from now (including any current presence)?	0% -10%	HIGH	Refer to Question 3.04
3.07	What other timeframe would be appropriate to estimate any significant further spread of the organism (10, 20, 40, 80 or 160 years)? Please comment on why this timeframe is chosen.	10 years	HIGH	In the absence of restrictions on sale and the implementation of routine biosecurity measures, the further spread of angling carp is considered likely. Any spread of ornamental carp is lightly to be much slower and will depend on the incidence of human-mediated introductions from aquarium or pond 'dumps'. In addition, in the longer-term, if climate change results in higher temperatures, reproduction potential may be enhanced thus enabling the establishment of additional self-sustaining populations and facilitating further spread.
3.08	In this timeframe, what proportion of the endangered area (including any currently occupied areas) is likely to have been invaded by this organism?	0% - 10%		Refer to Question 3.07.
3.09	Based on the answers to questions on the potential for establishment and spread in Ireland, define the area endangered by the organism. Be as specific as possible. If available, provide a map showing the area most likely to be endangered.	-	HIGH	In Ireland, there is an abundance of suitable waters for *C. carpio* to establish in. The species is most suited to soft-bottomed, well-vegetated, slow-flowing or static lowland waters (Inland Fisheries Ireland 2013).
3.10	Estimate the overall potential for future spread for this organism in Ireland (very slowly, slowly, moderately, rapidly or very rapidly). Use the justification box to indicate any key issues .	MODERATE	HIGH	The principal mechanism of spread is through the illegal stocking or transfer of common carp for angling purposes. The potential for the spread of ornamental carp is considered low due to their exceptional occurrence in the wild in Ireland.

Stage 2 - Detailed assessment: Section D - Impact

This section evaluates the probability of impact of an organism within Ireland.

N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
4.01	How great is the economic loss caused by the organism within its global distribution (excluding Ireland), including the cost of any current management?	MAJOR	VERY HIGH	There are no overall costs available in the literature to determine the economic loss caused by *C. carpio* within its global distribution. Major costs can be incurred for both public and private sectors by the species damaging aquatic habitats, the degradation of native fish stocks and the lowering of water quality. Affected sectors include domestic and irrigation water supplies, agriculture, and commercial and recreational fisheries (Arlinghaus and Mehner 2003; Miller and Crowl 2006; Jackson *et al*. 2010; reviewed in Kulhanek *et al*. 2011; reviewed in Nico *et al*. 2013).
4.02	How great has the economic cost of the organism been in Ireland from the time of introduction to the present? Exclude any costs associated with managing the organism from your answer.	LOW	HIGH	This information is not available. It is likely that because of the generally confined distribution of *C. carpio* in Ireland, no significant economic costs have been incurred to date.
4.03	How great is the economic cost of the organism likely to be in the future in Ireland? Exclude any costs associated with managing the organism from your answer.	LOW	MEDIUM	An overview of known economic impacts that occur globally is outlined in response to Question 4.01. In Ireland, if there is adherence to official stocking guidance (which is designed to minimise impacts to native species and habitats) and relevant legislation (e.g. EC Habitats Directive) it is anticipated that the future economic cost of the organism will be low. In the absence of compliance by stakeholders in this regard, or an increased capacity for reproduction as result of climate change, greater economic costs would likely be incurred than presently foreseen.
4.04	How great have the economic costs of managing this organism been in Ireland from the time of introduction to the present?	MINOR	VERY HIGH	Specific information is not available. Routine economic costs have been incurred as a result of fish stocking and ornamental imports, breeding programmes, disease testing, fish transfers and the management of fisheries since its introduction (Brazier *et al*. 2012).
4.05	How great is the economic cost of managing this organism likely to be in the future in Ireland?	MODERATE	MEDIUM	Further to Question 4.01, this is dependent on its future spread outside of its current range in Ireland, particularly to open water systems as well as an increase in its capacity to establish self-sustaining reproductive populations in such waters. The level of compliance with stocking guidance and relevant legislation and the effects of climate change will be factors to determine future management costs. It is likely that *C. carpio* illegally stocked or transferred for angling purposes would be responsible for the vast majority of future economic costs associated with managing this species, particularly as such practices typically involve the transfer of multiple specimens.

Stage 2 - Detailed assessment: Section D - Impact

This section evaluates the probability of impact of an organism within Ireland.

N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
4.06	How important is environmental harm caused by the organism within its global distribution?	MAJOR	VERY HIGH	The primary mode by which *C. carpio* causes environmental harm results from its ability to alter substantially the physical characteristics of invaded habitats. Such impacts can result in shifts from clear, high quality waters with high macrophyte densities to turbid, heavily degraded systems (reviewed in Weber and Brown 2009; Vilizzi *et al.* 2014b). *C. carpio* can affect rooted plant and benthic macroinvertebrate densities, phytoplankton biomass, and zooplankton abundance; and as a result, ultimately affect the abundance of native fish species (reviewed in Weber and Brown 2009; Kulhanek *et al*. 2011). The severity of the impacts caused by *C. carpio* is largely dependent on its local density (Kulhanek *et al*. 2011). *C. carpio* can act as a vector for diseases, notably for Spring Viraemia of Carp (SVC) that is also fatal to some other fish species (Ahne *et al*. 2002).
4.07	How important has the impact of the organism on biodiversity* been in Ireland from the time of introduction to the present? *e.g. decline in native species, changes in community structure, hybridisation	MIMINAL	HIGH	As *C. carpio* is largely confined to isolated waters or is at very low density levels in natural systems, widespread impacts to date have likely been minimal, although no specific studies have been undertaken in this regard.
4.08	How important is the impact of the organism on biodiversity likely to be in the future in Ireland?	MODERATE	HIGH	This is dependent on the future spread and level of establishment of this species in Ireland which will likely be determined by the factors outlined in answer to Questions 4.05. Potential impacts to biodiversity are outlined in answer to Question 4.06, the magnitude of which are principally influenced by local carp density (Kulhanek *et al*. 2011). It is likely that *C. carpio* illegally stocked or transferred for angling purposes would be culpable in this regard, particularly as such practices typically involve the transfer of multiple specimens. Ornamental koi are anticipated to have a minimal impact on biodiversity as, at least, to date, introductions to the wild in Ireland have been exceptional and limited to single specimens to the knowledge of the authors. In addition, ornamental koi in Ireland are predominantly confined to aquaria or small landlocked ponds.
4.09	How important has alteration of ecosystem function* caused by the organism been in Ireland from the time of introduction to the present? *e.g. habitat change, nutrient cycling, trophic interactions	MINIMAL	HIGH	Refer to Question 4.07.

Stage 2 - Detailed assessment: Section D - Impact

This section evaluates the probability of impact of an organism within Ireland.

N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
4.10	How important is alteration of ecosystem function caused by the organism likely to be in Ireland in the future?	MODERATE	HIGH	Refer to Questions 4.05, 4.06 and 4.07.
4.11	How important has decline in conservation status* caused by the organism been in Ireland from the time of introduction to the present? *e.g. sites of nature conservation value, WFD classification, etc.	MINIMAL	HIGH	There has been no known decline in conservation status caused by *C. carpio*.
4.12	How important is decline in conservation status caused by the organism likely to be in the future in Ireland?	MODERATE	HIGH	There is a strong likelihood based on known impacts elsewhere that any significant expansion in the range of *C. carpio* (refer to Question 4.06), particularly to open water systems, coupled with an increased ability to reproduce successfully and establish self-sustaining and abundant populations, has the potential to result in detrimental impacts to native habitats and species in Ireland. This may result in the downgrading of ecological status under the Water Framework Directive and may also have implications for Natura 2000 sites. It is likely that *C. carpio* illegally stocked or transferred for angling purposes would be culpable in this regard. Ornamental koi varieties are anticipated to have a minimal influence on any decline in conservation status due to the manner in which they are predominantly confined to aquaria or small landlocked ponds.
4.13	How important is social or human health harm (not directly included in economic and environmental categories) caused by the organism within its global distribution?	MINIMAL	VERY HIGH	
4.14	How important is social or human health harm (not directly included in economic and environmental categories) caused by the organism within Ireland?	MINIMAL	VERY HIGH	
4.15	How important is it that genetic traits of the organism could be carried to other organisms / species, modifying their genetic nature and making their economic, environmental or social effects more serious?	MINIMAL	VERY HIGH	Highly unlikely - there is no evidence for this.

Stage 2 - Detailed assessment: Section D - Impact

This section evaluates the probability of impact of an organism within Ireland.

N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
4.16	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	HIGH	*C. carpio* is a commonly used as a food source in many countries throughout the world and historically has been stocked in new locations for this purpose. It can act as a vector for diseases, notably for Spring Viraemia of Carp (SVC) and Koi Herpes Virus (KHV) that are also fatal to some other fish species including tench, roach, rudd and pike (Ahne *et al*. 2002). In Ireland, *C. carpio* is less commonly used for food and Irish law currently restricts the retaining of angling caught carp for consumption to a maximum daily catch of 4 fish <25 cm in length. However, in recent times, the increase in immigration from countries where *C. carpio* is a common food (cf. eastern Europe: Balon 2005) has likely increased its consumption in Ireland.
4.17	How important might other impacts not already covered by previous questions be resulting from introduction of the organism? Specify in the justification box.	MINIMAL	HIGH	All known impacts have been covered elsewhere in this document.
4.18	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 Ireland?	MINIMAL	HIGH	*C. carpio* is not naturally controlled by any predator, parasite or pathogen in Ireland. Although, some predation may occur on stocked juvenile carp by pike in some waters (J. Caffrey IFI pers. comm.). Koi Herpes Virus has been detected in two imports of koi in 2005 and 2007, respectively (McCleary *et al*. 2012) but it has not been detected in Irish stocks or imports since that time.
4.19	Indicate any parts of Ireland where economic, environmental and social impacts are particularly likely to occur. Provide as much detail as possible, where possible include a map showing vulnerable areas.		HIGH	In Ireland, there is an abundance of freshwater habitats (e.g. lakes, slow flowing rivers, ponds, canals and other artificial watercourses) suitable for the survival and development of *C. carpio*. The species is known to reproduce successfully and maintain self-sustaining populations in at least three waters in Ireland (Brazier *et al*. 2012). This capacity for reproduction is predicted to expand considerably if water temperatures rise as result of climatic change (Britton *et al*. 2010; J. Caffrey IFI pers. comm.). Under these circumstances, the potential for *C. carpio* to establish in abundance and disperse widely in open or semi-open (i.e. canals) systems once stocked would be high. The timeframe where climate change could exert a positive influence on water temperatures to favour greater *C. carpio* spawning is uncertain.

Stage 2 - Detailed assessment: Section D - Impact

This section evaluates the probability of impact of an organism within Ireland.

N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
4.20	Estimate the overall potential impact of this organism in Ireland. Use the justification box to indicate any key issues.	MODERATE / MAJOR	MEDIUM	Potential impacts are largely dependent on (1) the future stocking regime or internal transfer of *C. carpio* for angling purposes in Ireland (legal or illegal); (2) the ability of *C. carpio* to spread further in open or semi-open natural or artificial waters where they are already present; (3) an increased ability of *C. carpio* to reproduce and establish self-sustaining populations due to rising water temperatures; and (4) the local densities of *C. carpio* achieved as a result of these factors. As mentioned previously in this document, official *C. carpio* stocking guidance for angling purposes is undertaken cognisant of minimising any potential ecological impacts. Because of this, illegal introductions for angling are more likely to be responsible for any negative impacts. It should also be noted that the timeframe where climate change could exert a positive influence on water temperatures to favour greater *C. carpio* fecundity is uncertain. Ornamental koi varieties are anticipated to have a minimal impact as they are predominantly confined to aquaria or small landlocked ponds and are not introduced to or transferred between waters for angling purposes.

Stage 2 - Detailed assessment: Section E - Conclusion

This section requires the assessor to provide a score for the overall risk posed by an organism, taking into account previous answers to entry, establishment, spread and impact questions.

N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
5.01	Estimate the overall risk of this organism in Ireland (noting answers given in 1.11, 2.16, 3.10 & 4.20).	MODERATE / MAJOR	MEDIUM	It is considered that *C. carpio* illegally stocked or transferred for angling purposes pose a greater risk in Ireland than the ornamental varieties for the reasons provided in response to Question 4.20.

Stage 2 - Detailed assessment: Section F – Additional questions

This section is used to gather information about the potential effects of climate change on the risk posed by an organism. It is also an opportunity for the risk assessor to highlight high priority research that could help improve the risk assessment.

N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
6.01	What aspects of climate change, if any, are most likely to affect the risk assessment for this organism?		HIGH	Climate change is expected to increase water temperatures over time in Ireland, with increased periods of drought in summer and higher rainfall in winter leading to more flooding events (Desmond *et al*. 2008). In Ireland,

Stage 2 - Detailed assessment: Section F – Additional questions

This section is used to gather information about the potential effects of climate change on the risk posed by an organism. It is also an opportunity for the risk assessor to highlight high priority research that could help improve the risk assessment.

N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
				self-sustaining (i.e. reproducing) populations are not commonplace (but do exist) as water temperatures (<18 ^{o}C) are generally inadequate for spawning (Brazier *et al.* 2012; Inland Fisheries Ireland 2013). Therefore, if water temperatures increase, this may enhance reproductive capability and result in the wider perpetual establishment of this species. Climate-matching modelling and air and water temperature regression modelling on Carp in England and Wales, suggest that relatively small increases in water temperature are likely to enhance their ability to establish and become invasive as propagule pressure increases (Britton *et al.* 2010). In Ireland, in recent years, mean water temperatures reach 18^{o} C or greater for prolonged periods only in occasional years (Inland Fisheries Ireland, unpublished data).
6.02	What is the likely timeframe for such changes (5, 10, 15 , 20, 50 or 100 years)?	50 YEARS	LOW	Confidence is given as low as it is difficult to predict with any certainty the timeframe as to how climate change will influence the rate of increase in water temperatures in Ireland or indeed, if it will at all. However, stochastic modelling of *C. carpio* population dynamics (Brown and Walker 2004; Forsyth et al. 2014) coupled with pest management-based meta-population models (Brown and Gilligan 2014) may help refine estimation of such timeframes.
6.03	What aspects of the risk assessment are most likely to change as a result of climate change		LOW	Refer to responses to Question 6.01 and 6.02.
6.04	If there is any research that would significantly strengthen confidence in the risk assessment, please note this here. If more than one research area is provided, please list in order of priority.			Research on the impact of *C. carpio* on the ecology of colonised waters in Ireland would further strengthen aspects of the risk assessment. At present, there are two PhD research projects ongoing based on this species in Ireland in University College Cork. One focuses on their "growth, diet, reproduction, survival and recruitment, what the implication of fish domestication is for wild populations and general fisheries ecology and management". (http://www.ucc.ie/en/bees/staff/researchstudents/brazier/index.html) and the other aims to "investigate common carp distribution and potential impact to natural ecosystems in Ireland." (http://www.ucc.ie/en/afdc/documents/AFDCNewsletterIssue3SpringSummer2012.pdf).

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