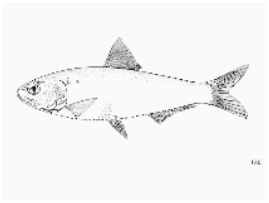
APPENDIX 7: DESCRIPTION OF SPECIES

In this section there is a description of the species named before. The life cycle, and relevant factors for the migration and food web are briefly summarized.

Anadromous

Alosa alosa



Type	Anadromous, pelagic, eggs are laid on the bottom
Red list status	(2) Critical
Type of threats	(2) Water level management, pollution, eutrophication
Major problems	(2) no population exits anymore; spawning area is inaccessible, poor water quality
Food	Piscivorous
Languages	Allis shad (english), elft (dutch), sábalo (spanish)

Life cycle

In spring, when the water is above 11-12 ^{o}C, allis shad enter, in small schools, into the river to spawn (de Groot, 1989). The male enters a few weeks earlier in spring than the female. Spawning takes place in May – June, mainly during the night in the upper water levels, above a gravel bottom. The eggs are fertilised in mid-water and sink to the bottom (de Groot, 1989). The spawned fish leaves the river and comes back to the sea. Depending on the water temperature, larvae emerge within 4-8 days (22-24 ^{o}C) (de Groot, 1989). The larvae and young fish are transported downstream into the freshwater tidal area, where by using a vertical diurnal-rhythm combined with ebb and flood movement of the water they can maintain themselves in the estuary for over one year (Wheeler, 1978).

Alosa fallax

Type	Anadromous (Fam. Clupeidae), pelagic, eggs are laid on the bottom (2)
Red list status	(2) Vulnerable
Type of threats	(2) Water level management, pollution, eutrophication
Major problems	(2) Spawning area becoming inaccessible, loss of spawning habitat
Food	(9) Planktivorous, piscivorous
Languages	Twaite shad (English), fint (dutch), saboga (spanish)

Life cycle

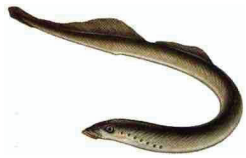
In spring, from April to June, when the temperature of the water is 10.6-12.3 ^{o}C (Aprahamian, 1998), the twaite shad enters river mouths to spawn in or just above tidal reaches (Hartgers et al., 1998). One requirement is that this species needs a gradual transition from salt water to fresh water. They spawn in the lower reaches of the river where the influence of tide is just observable. The bottom where the eggs are laid is sandy with small stones and vegetation (nest lining) (Jager, 1999). Juveniles emigrate seaward in the autumn of their first year, and the timing of these migrations is believed to temperature-related (Claridge & Gardener, 1978).

Acipenser sturio

Type	Anadromous , benthic, eggs are laid on the bottom
Red list status	(2) Extinct
Type of threats	(2) Water level management, pollution, exploitation
Major problems	(2) Population is extinct, reproduction occurs at an older age with a relatively small number of eggs (that are also in high demand for human consumption: caviar), spawning habitat has probably disappeared.
Food	Insectivores: zoobenthos Piscivorous, Planctonivores
Languages	Atlantic sturgeon (english), steur (dutch), esturion (spanish)

Life cycle

The atlantic sturgeon is an amphihaline and potamodromous fish frequenting littoral zones. Juveniles are found both in estuaries and in the sea. The atlantic sturgeon is an anadromous species which migrates to the freshwater in order to spawn. Sexually mature at an age of 7-9 years. In spring, April and May, Atlantic sturgeon begins the migration to freshwater. It is a demersal species. It enters into the river mouths to spawn in or just above tidal reaches (1) , usually solitarily. The spawning temperature it is around 14-19 ^{0}C in a depth of 6-8 meters in gravel bottoms. The adults leave after spawning. The habitat of the juvenile is in the lower reaches of the rivers. Young fish stay in freshwater for up to 3 years.



Lampreta fluviatilis

Type	Anadromous, benthic, eggs sheltered in a nest or brood pouch (2)
Red list status	(2) Vulnerable
Type of threats	(2) Water level management, pollution, eutrophication, possible exploitation
Major problems	(2) accessibility to spawning area, suitability of nursery area
Food	(9) Piscivorous (paras.)
Languages	Lampern (english), rivierprik (dutch), lamprea de río (spanish)

Life cycle

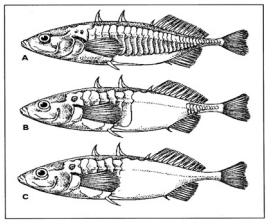
Lampreta fluviatilis is an anadromous species which migrates from the sea to the fresh water to spawn when they are adults. Lamperns spend at least twelve months in the sea. During this time they are parasitic, feeding on the blood and body tissues of other fish (Wheeler, 1969). Fishes known to have been attacked are often migratory and brackish-water species such as the houting, sea trout and shad, which suggests that the lamperns do not move far out to sea. After the rich feeding of their marine life they enter rivers in autumn and spend the winter in fresh water, fasting. During this time the secondary sexual characters develop and the gut atrophies (Wheeler, 1969). Spawning occurs in spring when the water is less than 20 ^{0}C in the middle –upper reaches of river. The lampern chooses spawning sites of small pebbles on a sandy bottom, usually at least partly in the shade, with a depth of 0.2-1.5 m with a flow of 100-200 cm/s (2).

Osmerus eperlanus

Type	Anadromous, pelagic, eggs are laid on the bottom
Food	(9) Piscivorous. Insectivores: zoobenthos
Red list status	(2) Not applicable
Type of threats	(2) Water level management, pollution, eutrophication
Major problems	(2) Spawning area becoming inaccessible, loss of spawning habitat
Languages	smelt (eng.), spiering (dutch), eperlán (spanish)

Life cycle

It is possible to find two forms of smelt in the IJsselmeer: migratory smelt (Jager, 1999) and a land locked form (non-migratory) The latter has increased enormously since the dam was built (Jager, 1999), although it is now known its origin. Between these forms there is basically a difference of size. The "freshwater smelt" are smaller than the anadromous variety. The migratory smelt obtains a length of up to 30 cm in its eighth year (Mohr, 1994). The non-migratory smelt in the freshwater lakes and large rivers has a length of 8-15 cm. But the non-migratory smelt is, however, not common (de Groot, 1989), except precisely in lake IJsselmeer. The sea smelt becomes sexually mature at the age of 3 or 4, inland smelt at 1 or 2 years of age. Both smelt types spawn mainly in rivers migrating from the sea or lakes. The migratory smelt migrates to the estuaries during the winter, at the end of February, and stays there till April. Then, this species migrates upstream to reproduce (Jager, 1999). The non-migratory smelt spawns in lakes and rivers. In both cases, spawning takes place from Feb-April, when temperatures are between 4-12 ^{o}C.
The number of eggs could vary from 9.000 to 40.000. Eggs are laid and stuck to stones, gravel, water plants, but never on silt bottoms (Groot, 1989). The larvae usually hatch 2 to 5 weeks later depending on water temperature.
Smelt needs water with high oxygen levels, at least around 5 mg/l and disappears from the estuary if these conditions are not met (Jager, 1999).



Gasterosteus aculeatus

Type	(2) Anadromous, pelagic, eggs are guarded by one or both parents
Red list status	(2) Not applicable
Type of threats	(2) Being pumped in with water to be used as cooling water
Major problems	(2) Passing saltwater-freshwater transitions
Food	(9) Insectivores: zoobenthos. Piscivorous
Varieties	(2) There are three varieties that migrate to various degrees between salt water and fresh water: *trachurus* (A), *semiarmatus* (B) and *leiurus* (C).
Languages	Three-spined stickleback (eng.), driedoornige stekelbaars (dutch), espinoso (spanish)

Life cycle

There are three varieties of three-spined sticklebacks depending on the degrees of migration between salt and fresh water. The *trachurus* is the anadromous variety which can be identified because its body length is completely covered by bony plates (Jager,

1999). The *semiarmatus* has no bony plates in the middle and *leiurus* only in the front part of the body.

The adults in their second year of life migrate to fresh water in spring (de Boer, 2001). The period of migration for three-spined sticklebacks is in February, March and April. Three-spined stickleback use the tides for the migration because it is a bad swimmer. When the temperature is 14-19 ^{o}C, they spawn, which occurs in April till August. The spawning habitat requirements are vegetation in the area and open areas (de Boer, 2001). This species can stand an abrupt transition to fresh water into saltwater. The eggs are guarded by one or both parents in a nest lining made by plant materials. The substrate has to be sandy with small stones and vegetation (Jager, 1999). During high water is when they migrate (Ybema & Backx, 2001). An important feature of the reproductive biology is nest raiding and egg eating (Kedney, 1987).

In fresh water the stickleback is an important source of food for several bird species including the spoonbill, bittern, grebe, cormorant, heron, merganser, and tern (Wintermans, 1998).

Salmo salar

Type	Anadromous
Food	
Red list status	critical
Type of threats	water level management, eutrophication, exploitation, possibly pollution
Major problems	homing is lacking because there is no population left, impassability of sluices, weirs on rivers, water quality of river, lack of suitable spawning area, nursery area has been affected
Languages	Atlantic salmon (eng.), zalm (dutch), salmón (spanish)

Life cycle

The atlantic salmon spawns in winter (generally November –December) in the rivers when the current is approximately 1 m/s. The eggs are deposited in the gravel. After hatching, young or alevins remain in gravel feeding off the rest of the yolk. Fry emerges from the gravel, begins to feed and develops into a parr. This last stage can last from one to eight years. Before anadromous salmonids migrate from freshwater to sea water, they change from parr into smolt, which migrate to the sea. This species has the ability to return to the place where it was born (homing ability). If the atlantic salmon returns to the spawning area in the river within one year, it is called grilse or Jacob's salmon (61- 67 cm), but if it stays away for approximately 2 to 5 years, it is named salmon. Historically, salmon caught in spring in the Rhine were grilse. Salmon remaining another year (83-91 cm), normally returned in May-July into the rivers. Old salmon, winter salmon (103-115 cm), reaches the Rhine in September, October. The adult salmon does not feed in the freshwater. The salmon which survives the spawning returns to the sea and is called kelt (van Brummelen, 1990). Only 5 % of the adult fish spawn two times.

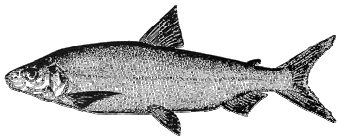
Salmo trutta

Type	Anadromous
Red list status	Endangered (Netherlands: susceptible)
Type of threats	Water level management, eutrophication, exploitation, possibly pollution
Major problems	Difficulty in passing through sluice, inaccessibility to spawning area, poor water quality
Food	
Languages	Sea trout (english), zeeforel (dutch), trucha común (spanish)

Life cycle

The period of migration of sea trout it is in the months from May-August.

Adult trout lives in the open sea. Adult fishes swim upstream in the period from June to September when they spawn. The fishes return to sea from January to June. Juveniles grow up downstream and stay 1-3 years in fresh water. The juvenile fishes swim downstream merely at night. Trout uses the IJsselmeer not only as a corridor for the migration cycle, but partly as a temporal forage area. Adult fishes live in open sea. The spawning areas are upstream oxygen-rich rivers on rocky grounds. The temperature during migration is 14-20 ˚C.



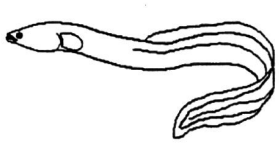
Coregonus lavaretus oxyrhinchus

Type	anadromous
Red list status	extinct
Type of threats	
Position in water	all the water column
Food	predator of zooplankton and bottom organisms
Languages	houting (eng.), houting (dutch),

Life cycle

From August till November, the adult of houting live in the brackish zone of the estuaries. The fishes are found in oxygen-rich oligotrophic rivers. The fishes prefer deep waters. The migration period is in October and November. When the temperature is less than 7 ^{0}C, the houting leave the estuary and go to the lower parts of the river to spawn. It does not use the tidal movements during the migration for it is a good swimmer. The spawning time is in November and December upstream. Spawning takes places in sandy river soils with high currents.
The houting population in Europe is classified as endangered (Hartgers, 1998). The fishes have a low production and therefore fisheries are easily deleterious for the population. Other factors, like low water quality, unreachable spawning areas, and low oxygen-concentration, are reducing the amount of eggs. Other problems are the disappearance of the original population, pollution and eutrophication. Because the big amounts of barrier works, like the Afsluitdijk, the brackish zone has diminished.

Catadromous

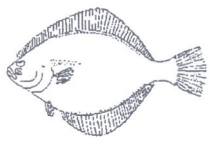


Anguilla anguilla

Type	(2) Catadromous, eurytopic, benthic
Red list status	(2) Vulnerable
Type of threats	(2) Exploitation, water level management, eutrophication, pollution
Major problems	(2) gaps in knowledge regarding autecology, international aspects regarding maintaining populations (all european eels belong to the same population)
Food	(9) Piscivorous. Insectivores: zoobenthos. Planctonivores :
Languages	eel (english), aal (dutch), anguila (spanish)

Life cycle and migration

The transport of the eel larvae from the mating place (Sargasso Sea) to the European coast is done passively by Golf currents. They arrive to the North Sea in autumn and it seems that they can reach the coast by selective tide transport (Jessop et al., 2000). The migration period is between the months of January and June, with a peak in April and May. It is not clear how eel can find the fresh water (Dekker & van Willigen, 2000). The selective tidal transport consists in: when there is flood tide, the glass eel swims in the high level of the water column, and when there is ebb tide, it stays in the bottom and it does not move. The eel continues its migration into the rivers and along the sea shores (Wheeler, 1978). Once the eel reaches certain level of the estuaries or river, because of lack of tides in these areas, they cannot use the selective transport. Then they are forced to active migration. This active migration costs a lot to the eel. Its maximum speed is 50 cm/s and the velocity of the flow in the Rhine is approximately 100 cm/s (Dekker & van Willigen, 2000). Because of that, this migration depends highly on temperature factor, and it must be approximately 5-10 ^{o}C. In the fresh water, the glass eel accumulates more pigment and it is called red eel. Between 2 to 5 years the red eel will change its stadium to the reproductive stage.
After living for between five and ten years in fresh water, they return to spawn and die in the waters of the Sargasso Sea, in the south western part of the North Atlantic.



Platichthys flesus

Type	(2) Cadromous, benthic, pelagic (free-floating) eggs, euryhaline (salt tolerant)
Red list status	(2) not applicable
Type of threats	(2) Loss of habitat and pollution.
Major problems	(2) Impassability of sluices
Food	0^{+} group flounder of 30 –50 mm: (Copepoda, Oligochaeta and Polyachaeta)
Languages	flounder (eng.), bot (dutch), platija (spanish)

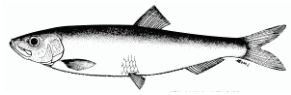
Life cycle

The flounder is an euryhaline (fresh water tolerant) flatfish species with a coastal distribution. Its ability to live in low-salinity water and its preference for these environments are features that do not occur in other European flatfish (Jager, 1999). In the former Zuiderzee, huge concentrations of juvenile flounder were found near of the outflow of the river IJssel (Redeke, 1908).

Flounder reproduce in the North Sea (Redeke 1908), but adult flounders remain primarily in estuaries and in the Wadden Sea for the rest of the year (Jager,1999). In the North Sea, the pelagic (free-floating) eggs develop. The spawning period is in winter around February. Highest concentration of eggs was observed in February in the west and north west of the dutch west coast (Van der Land, 1991). Larvae hatch around 5-7 days depending on the temperature of the water. The lengths of the larvae are approximately 2.25-3.30 mm (Redeke, 1908). The distribution of early larval stages seems to be mainly determinated by the process of advection and diffusion, the older larvae concentrating near the estuaries (Grioche et al., 1997). In May, larvae of flounder float along in residual currents to the coast and enter such areas as the Wadden Sea through large tidal inlets. Then, the metamorphosis from pelagic larvae to flatfish occurs on the bottom. In this process there are huge transformations that permit the transition from a pelagic to a benthic life-style. This new adaptation provides new food sources and the avoidance of predators. The first bottom- living stages were caught by the end of April in brackish-water areas near river mouths (Redeke, 1908). The larval transport is facilitated by selective tidal transport in the nursery. When temperatures decreases in autumn, the juveniles leaves the nursery to remain in deeper waters during the winter months.

Marine

Marine juvenile



Sprattus sprattus

Type	Marine juvenile
Red list status	
Type of threats	
Major problems	
Food	Insectivores, piscivores
Languages	sprat (eng.), sprot (dutch), espadín (spanish)

Life cycle

Sprat is a usually inshore schooling species, sometimes entering estuaries (especially the juveniles) and tolerating salinities as low as 4 ppt. It shows strong migrations between winter feeding and summer spawning grounds. Moves to the surface at night. Feeds on planktonic crustaceans. Spawns at depths of 10-20 m producing 6,000 - 14,000 pelagic eggs. Some spawn almost throughout the year, mainly in spring and summer, near the coast or up to 100 km out to sea, the young drifting inshore.

Clupea harengus

Type	Marine juvenile
Red list status	
Type of threats	
Major problems	
Food	
Languages	Herring (eng.), arenque (spanish)

Life cycle

Herring, too, is a schooling species in coastal waters, with complex feeding and spawning migrations. Each stock seems to have preferred spawning and feeding and overwintering

grounds, and tagging studies have demonstrated the existence of annual migratory patterns between these areas.
Herring has undoubtedly a coastal nursery in the Wadden Sea. The juvenile of herring lives for a short period in coastal areas, on average up to 3-9 months, up to a length of about 10 cm (Zijlstra, 1978). It feeds on small planktonic copepods in the first year, thereafter mainly on copepods. The atlantic herring is primarily pelagic, and is often found in schools (sometimes huge), occurring in shallow inshore waters, or offshore from the surface down to depths of 200 m. A number of separate populations or stocks have been described occurring in the Wadden Sea. The two waves of young herrings may represent Downs herring, which were found in February-March of 1963, and Bank herring found in October-November in 1963.

References:
http://www.afprotein.com/herring.htm

Chelon labrosus

Type	Marine seasonal
Red list status	
Type of threats	
Major problems	
Food	
Languages	Thick lipped grey mullet (english), diklipharder (dutch), lisas (spanish)

Life cycle

Occurs inshore, enters brackish lagoons and freshwater. Migrates occasionally. Tends to move northward in summer time as the temperatures rise. Feeds mainly on benthic diatoms, epiphytic algae, small invertebrates and detritus. Reproduction occurs in the sea during winter. Eggs and larvae pelagic.

Liza ramada

Type	Marine seasonal
Red list status	
Type of threats	
Major problems	
Food	(9) Insectivores: zoobenthos, planctonivores, detritivores, herbivores
Languages	thin lipped grey mullet (eng.), dunlipharder (dutch), mugil (spanish)

Life cycle

Usually inshore, entering lagoons and estuaries and rivers between temperatures 8-24°C. Lives well in saline lakes but spawns in the sea. Feeds on epiphytic algae, detritus and small benthic or planktonic organisms, pelagic eggs and larvae. Reproduction takes place in the sea, from October to December.

References in the chapter indicate as numbers:

(1) Salmonids and other migratory fish in Lake IJsselmeer. Hartgers, 1998.
(2) Upstream fish migration: Northern Netherlands coastal zone, RIKZ report, Jager, 1999.

(3) Rehabilitation of diadromous and estuarine fish populations in the Rhine and Meuse estuary through alternative sluice management. Ybema & Backx, 2001.
(4) Zeldzame vissen in het IJsselmeergebeid (Jaarrappot, 2000). Hartgers, 2000.
(5) Key to the Fishes of Northern Europe, Alwyne Wheeler, 1978
(6) The former Allis and Twaite shad fisheries of the lower Rhine, The Netherlands. Groot S. J.1989 (Internationla council for the exploration of the sea) C11981
(7) The biology of the twaite shad, Alosa fallax fallax in the Severn Estuary .Aprahamian.
(8) Vismonitoring IJsselmeer en Markermeer in 2000, J.J. de Leeuw, W. Dekker, D.J. Sluis
(9) Leeuw & Backx, 2001

http://www.fishbase.org/Summary/SpeciesSummary.cfm?genusname=Liza&speciesname=ramada
http://www.fishbase.org/larvalbase/Summary/LarvaSummary.cfm?genusname=Chelon&speciesname=labrosus