

Stressor Analysis for Atlantic salmon in Germany

In the Federal Republic of Germany, the reintroduction of Atlantic salmon (*Salmo salar*) is taking place in nine of the German Laender (federal states)¹. Responsibility and expertise for the reintroduction projects lies with the individual federal states.

In order to carry out the stressor analysis, the scoring template developed by the NASCO EU delegation's scientists was sent to the responsible administrative bodies in the individual federal states, together with the explanatory notes and a completion assistance in German.

The Excel template was completed by the federal states on the basis of expert knowledge and returned to the Federal Office for Agriculture and Food (BLE) together with a written evaluation of the individual stressors.

The results obtained from the federal states were then averaged to provide a representative result for Germany as a whole. The overall result is presented in the form of a table and a graph (see annexes).

The individual stressors were described according to the given EU scheme:

Stressor No 1: Pollution

Effects

1. Number of affected populations (including lost populations) = 3.8

All Atlantic salmon populations in Germany come into contact with a wide range of water pollutants at some stage in their life cycle. For this reason, the number of populations affected by water pollution is classified as '4' in almost all of the relevant federal states.

2. Geographical distribution = 3.1

The quality of water in salmon habitats varies between and within the federal states depending on population density, intensity of industrial and agricultural use and the location of the water body in the catchment. One federal state considers all water bodies to be affected by point or diffuse inputs, another federal state considers only point inputs, while the remaining seven federal states consider the spatial impact of water pollutants to be regional.

3. Negative impact = 2.3

The negative impact of water pollutants is assessed by the federal states on average as moderate (four Laender assess the impact as high, four as moderate and one as low).

In terms of ecological impact, the Phosphorus and nitrogen compounds and micro pollutants (e.g. polycyclic aromatic hydrocarbons (PAC), per- and polyfluoroalkyl substances (PFASs) and hormone active substances) are particularly noteworthy.

4. Total score effects = 9.2

5. Knowledge = 1.7

The average level of knowledge of the stressor 'Pollution' is rated as moderate.

¹ Baden-Wuerttemberg (BW), Rhineland-Palatinate (RP), Hesse (HE), North Rhine-Westphalia (NRW), Saxony (SN), Saxony-Anhalt (ST), Brandenburg (BB), Lower Saxony (NI), Schleswig-Holstein (SH)

6. Compiled relative effect = 0.77

The calculated relative effect of the stressor 'pollution' is quite high. Despite a considerable improvement in the situation since the mid-1970s, the level of pollution must still be considered serious. This is confirmed by the status analysis of the EU WFD. The main impact of existing pollution is supposed on the reproductive success of returning salmon.

Developments

1. Potential for effective measures (planned) = 2

The assessment for future measures to improve water quality is moderate in the middle and upper reaches of the Rhine and poor in the lower reaches. The potential for improving water quality is assessed as high in the middle and upper reaches of the Elbe, and as poor in the lower reaches of the Elbe, Weser and Ems. Measures to modernise wastewater treatment plants and reduce discharges from agricultural land are generally progressing too slowly.

2. Likelihood of further negative impacts (due to reduced production capacity or freshwater survival or marine survival) = 2.3

Six federal states rate the likelihood that the negative impact of water pollutants will increase in the future as moderate, while three Länder rate this criterion as high. Among other things, higher concentrations of pollutants are expected during extremely low water discharges and increased discharges of untreated mixed water loads during extremely heavy rainfall due to climate change. The toxicity of new synthetic compounds and trace elements introduced into water bodies has not yet been sufficiently researched, and examples of such compounds include 6PPD quinones, which are introduced via micro plastics, tyre abrasion, operating materials and fine sediments from directly connected road drainage systems.

3. Total score developments = 4.3

4. Uncertainty of projected developments = 1.9

On average, the uncertainty of the ratings given is assessed as moderate. One federal state indicates a high level of uncertainty, six states a medium level and two states a low level.

5. Compiled relative developments = 0.54

Much has been done in the past to reduce levels of pollutants in water and this issue has receded as a threat to salmon, but in recent years, extreme weather events have brought the stressor "Pollution" back to the fore.

Score for 'Knowledge & uncertainty of projected development Compiled Scores' = 4
(3.56)²

- moderate knowledge & moderate uncertainty with regard to the characterisation of the stressor "Pollution"

² The compiled scores were rounded to whole numbers and evaluated according to the following scheme: 3= good knowledge and low uncertainty; 4= moderate knowledge & moderate uncertainty; 5= poor knowledge & large uncertainty

Stressor No 2: Barriers

Effects

1. Number of affected populations (including lost populations) = 3.8
Migration barriers affect almost all of the salmon stocks in Germany.
2. Geographical distribution = 3.9
Almost everywhere in Germany, salmon and other migratory fish are severely hampered by migration barriers.
3. Negative impact = 3,8
All adverse effects on salmon listed by the ICES Working Group on Effectiveness of Recovery Actions for Atlantic salmon (ICES, 2017) under the stressor 'Barriers' occur to a significant extent in Germany.
4. Total score effects = 11.4
5. Knowledge = 1.2
Most of the transverse structures in the watercourses and their fish passability have been mapped, so there is a good level of knowledge about the stressor 'Barriers'.
6. Compiled relative effect = 0,95
The negative effect of barriers on salmon stocks in Germany was rated the highest of all twelve stressors. This assessment was almost identical in all federal states.

Developments

1. Potential for effective measures (planned) = 1.9
The potential for planned effective measures is evaluated as 'high' by two Laender, as 'moderate' by five Laender, and as 'poor' by one federal state. The mean evaluation for Germany as a whole is 'moderate'.
2. Likelihood of further negative impacts (due to reduced production capacity or freshwater survival or marine survival) = 2.6
The probability that negative factors related to barriers could increase is assessed as moderate to high. The reasons for this include the ongoing (or repeated) discussion of the commissioning or construction of new hydropower plants. Changes in the legal situation (e.g. overriding public interest in the generation of renewable energy according to the *Renewable Energy Sources Act*) may lead to setbacks for large hydropower plants with turbines larger than one megawatt (fish protection concerns may be weighed up for the benefit of energy generation, 'transitional solutions' already achieved at individual sites may be reversed). Measures to mitigate certain impacts, particularly on federal waterways classified as heavily modified water bodies under the WFD, are often not the focus of programmes of measures.
3. Total score developments = 4.4
4. Uncertainty of projected developments = 2
On average rated as 'Moderate'.
5. Compiled relative developments = 0,56
Given the assumption that the stressor 'Barriers' exerts an extremely deleterious effect on salmon stocks, the assessment of the relatively elevated value of 0.56 indicates the necessity for future action in this area to mitigate the negative impact of this stressor.

Score for 'Knowledge & uncertainty of projected development Compiled Scores' = 3 (3.22)

- Good knowledge & low uncertainty with regard to the characterisation of the stressor 'Barriers'

Stressor No 3: Water Regulation

Effects

1. Number of affected populations (including lost populations) = 3.9
Changes in river flow or hydraulic engineering affect almost all salmon stocks in Germany.
2. Geographical distribution = 3.3
The geographical distribution of this stress factor is, on average, rated as "regional" by the federal states.
3. Negative impact = 2.9
The detrimental effect of this stressor on salmon stocks is categorised as 'high' on average across Germany. This is attributable to the fact that substantial water regulation, frequently associated with hydropower, exerts a detrimental influence on the quantitative availability of habitat, structural diversity and habitat quality. A significant proportion of the historic salmon habitat has already been irreparably lost due to water regulations. Furthermore, hydraulic engineering frequently results in alterations to the flow regime, thereby impacting physical and chemical water parameters. A notable illustration of this phenomenon is the substantial intervention in the river bed in the lower reaches of the tidal Ems and the tidal Elbe. Water engineering projects, particularly the deepening of riverbeds, have been identified as a key factor in altering the flow regime in these areas, leading to a temporary reduction in the oxygen content of the tidal Elbe below the port of Hamburg during summer months. This reduction can result in the formation of a physical and chemical barrier to salmon migration. In the case of the tidal Ems, this condition persists from spring to autumn. This severe impairment was identified as significant by all five neighbouring federal states in the Elbe and Ems river basins, but in combination with other stressors (1x pollution, 1x barriers, and 3 x other). As this condition is primarily a consequence of hydraulic engineering measures, it should primarily be considered under the stressor 'Water Regulation'.
4. Total score effects = 10.1
5. Knowledge = 1.6
The level of knowledge related to this stressor was assessed as moderate.
6. Compiled relative effect = 0,84
The relative effect of water regulation is estimated to be very high at 0.84, making it one of the five most negative stressors on salmon stocks.

Developments

1. Potential for effective measures (planned) = 2
On average, the federal states assess the potential of the planned measures as moderate. However, many of the changes to water bodies caused by hydraulic engineering measures will be difficult to reverse in the medium to long term.
2. Likelihood of further negative impacts (due to reduced production capacity or freshwater survival or marine survival) = 3
The likelihood of an increase in factors that may adversely affect salmon stocks because of hydraulic engineering is estimated to be high on average.
3. Total score developments = 5
4. Uncertainty of projected developments = 2
Rated on average as "moderate"
5. Compiled relative developments = 0,63
Prospects for improvement in the near future of impacts on salmon habitats associated with the stressor "water regulation" are not considered particularly high by the federal states.

Score for 'Knowledge & uncertainty of projected development Compiled Scores' = 4 (3.56)

- Moderate knowledge & moderate uncertainty with regard to the characterisation of the stressor 'Water Regulation'

Stressor No 4: Exploitation

Effects

1. Number of affected populations (including lost populations) = 3.4
Theoretically, in all river basins where salmon restocking is practised, salmon fishing may increase mortality of adult salmon.
2. Geographical distribution = 2.4
The geographical distribution for the stressor 'Exploitation' is characterised as 'scattered'.
3. Negative impact = 1.6
The negative impact of illegal catches of salmon or unintentional by-catches is considered to be low by almost all federal states, with only one federal state considering the impact to be moderate and one other considering it to be very high.
4. Total score effects = 7.4
5. Knowledge = 2.2
The federal states assesses the level of knowledge on the stressor "Exploitation" very differently. Four Laender rate the level of knowledge as poor, two as medium and three as good.
6. Compiled relative effect = 0.62

The relative effect of the stressor 'exploitation' is estimated to be relatively high on average.

Developments

1. Potential for effective measures (planned) = 2.9
The development of the stressor 'exploitation' is assessed quite differently. One federal state estimates the potential for action as high, five as moderate and three as negligible.
2. Likelihood of further negative impacts (due to reduced production capacity or freshwater survival or marine survival) = 1.4
Considered as low by five federal states and moderate by four Laender.
3. Total score developments = 4.3
4. Uncertainty of projected developments = 1.4
The uncertainty in the projected development is considered rather low.
5. Compiled relative developments = 0.54
There is currently little evidence to suggest that the situation for salmon will deteriorate in the medium term due to the stressor 'exploitation'.

Score for 'Knowledge & uncertainty of projected development Compiled Scores' = 4 (3.67)

- Moderate knowledge & moderate uncertainty with regard to the characterisation of the stressor 'Exploitation'

Stressor No 5: Aquaculture

Effects

1. Number of affected populations (including lost populations) = 1,2
Fish that appeared to be commercially farmed salmon were detected sporadically and in small numbers in a tributary in the lower reaches of the Elbe and a tributary in the lower reaches of the Weser.
2. Geographical distribution = 1
Local.
3. Negative impact = 1
The only threat to wild salmon stocks from aquaculture comes from salmonid farms releasing infected fish. However, farms are subject to mandatory veterinary surveillance. The direct impact of aquaculture on salmon is therefore considered as low.
4. Total score effects = 3.2
5. Knowledge = 1.6
Assessed as good to moderate.
6. Compiled relative effect = 0.27
The relative effect of aquaculture influence is estimated to be small.

Developments

1. Potential for effective measures (planned) = 2.2
Estimated as moderate.
2. Likelihood of further negative impacts (due to reduced production capacity or freshwater survival or marine survival) = 1.1
Estimated as negligible.
3. Total score developments = 3.3
4. Uncertainty of projected developments = 1.44
Assessed as “Small”
5. Compiled relative developments = 0.42
Neither salmonid aquaculture in Germany nor escaped farmed salmon from salmon farms, e.g. in Norway, pose a significant risk to the status of salmon stocks in the medium term.

Score for ‘Knowledge & uncertainty of projected development Compiled Scores’ = 3

- Good knowledge & small uncertainty with regard to the characterisation of the stressor 'Aquaculture'

Stressor No 6: Habitat Degradation

Effects

1. Number of affected populations (including lost populations) = 3.8
Loss of habitat quality is affecting all salmon stocks in Germany.
2. Geographical distribution = 3.2
The average geographical distribution of the stressor “Habitat Degradation” is rated as regional.
3. Negative impact = 3.2
All of the adverse effects on salmon listed by the ICES Working Group on Effectiveness of Recovery Actions for Atlantic salmon (ICES, 2017) under the stressor 'Habitat Degradation' occur on a large scale in Germany. In particular, the accumulation of fine sediment in the river bed and the clogging of salmon spawning gravels is a major problem in many salmon reintroduction rivers. In addition, in some tributaries, mechanical water maintenance measures (especially mobilisation of fine sediments during weeding and bed clearing; removal of dynamic structural elements; removal of gravel banks; removal of habitats = submerged vegetation cushions, dead wood) are a major problem.
4. Total score effects = 10.2
5. Knowledge = 1.6
The level of knowledge regarding the negative effects of habitat degradation is assessed as good to moderate.
6. Compiled relative effect = 0.85

The relative effect of the stressor 'habitat degradation' is estimated to be very high (0.85), making it one of the five stressors with the strongest negative impacts on salmon stocks in Germany.

Developments

1. Potential for effective measures (planned) = 1.9
The analysis of the data indicates that the potential for planned measures to restore the habitat and prevent harmful factors, such as sediment inputs, is assessed by the federal states on average as moderate.
2. Likelihood of further negative impacts (due to reduced production capacity or freshwater survival or marine survival) = 2.8
The risk of an increase in habitat degradation is assessed as high, particularly in view of the future prioritisation of flood protection measures. In addition, an increase in habitat degradation is expected due to the increase in heavy rainfall events, which leads to an increased input of fine sediment into the waters. Major projects to improve Rhine navigation are currently planned in several sections of the Middle Rhine, which could severely affect the Rhine as a migratory habitat in these sections.
3. Total score developments = 4.7
4. Uncertainty of projected developments = 1.9
Rated as moderate.
5. Compiled relative developments = 0.58
Unfortunately, it must be stated that negative developments in the medium term cannot be ruled out for the stressor 'Habitat Degradation'.

Score for 'Knowledge & uncertainty of projected development Compiled Scores' = 3 (3.44)

- Good knowledge & small uncertainty with regard to the characterisation of the stressor 'Habitat Degradation'.

Stressor No 7: Diseases / Parasites

Effects

1. Number of affected populations (including lost populations) = 1.3
With regard to this stressor, all of the Laender state that they are marginally affected or have a lack of knowledge.
2. Geographical distribution = 1.4
The majority of the federal states assume that this stressor is only locally prevalent, which is reflected accordingly in the assessment. However, one federal state points out that most salmon occurring in the wild are affected in some way by parasites and diseases (see next point).
3. Negative impact = 1.2

The present analysis shows that most federal states assess the impact of this stressor as low, while two Länder assess it as moderate. However, it should be noted that investigations by one federal state have shown that adult salmon carry a number of pathogens in and on themselves that are bacterial, viral or fungal in nature. In addition, internal parasites and ectoparasites (salmon lice) have also been detected on ascended adult salmon. It is suspected that the high bacterial load in the rivers puts a strain on the immune system of the fish and has a negative impact on spawning success, although further investigations are still required in this regard. In freshwater, a heavy infestation of migrating salmon smolts with parasites such as the common fish fluke (*Cystobranchnus respirans*) has been documented, and the impact on the ecological fitness of the smolts is assumed as high in the case of heavy infestation.

4. Total score effects = 4

5. Knowledge = 2.2

The average level of knowledge about the impact of diseases and parasites is estimated to be moderate. However, most federal states do not carry out standardised field studies on this topic.

6. Compiled relative effect = 0.33

The relative effect of this stressor is estimated to be low.

Developments

1. Potential for effective measures (planned) = 2.9

The assessment of the potential for measures varies across the federal states. On average, it is categorised as low.

2. Likelihood of further negative impacts (due to reduced production capacity or freshwater survival or marine survival) = 1.2

The majority of the federal states classify the probability of an increase in negative influences due to this stressor as low.

3. Total score developments = 4.1

4. Uncertainty of projected developments = 2.4

On average, estimates of the uncertainty associated with future developments are moderate to high.

5. Compiled relative developments = 0.51

There are currently few indications that the situation with regard to the stressor 'Diseases/Parasites' will deteriorate in the medium term.

Score for 'Knowledge & uncertainty of projected development Compiled Scores' = 5 (4.67)

- Poor knowledge & large uncertainty with regard to the characterisation of the stressor 'Diseases/Parasites'.

Stressor No 8: Climate Change

Effects

1. Number of affected populations (including lost populations) = 4
All salmon stocks in Germany are affected by climate change.
2. Geographical distribution = 3.9
The Geographical distribution of this stressor is at the national level.
3. Negative impact = 2.9
The impact of climate change on salmon stocks is estimated to be highly negative on average. In addition, the consequences of climate change also amplify the negative effects of most other stressors in a variety of ways. When assessing this stressor, the federal states focussed in particular on the effects on salmon in freshwater. In the last 7-8 years, the consequences of climate change have been felt very drastically in German water courses and in many cases have had a very detrimental impact on the salmon reintroduction projects.
4. Total score effects = 10.9
5. Knowledge = 1.7
The level of knowledge on this topic is assessed as moderate.
6. Compiled relative effect = 0.9
The relative impact of climate change is estimated to be significant and is ranked as one of the five most important stress factors affecting salmon stocks.

Developments

1. Potential for effective measures (planned) = 2.8
The potential of measures to mitigate the consequences of climate change is considered limited.
2. Likelihood of further negative impacts (due to reduced production capacity or freshwater survival or marine survival) = 3.3
The probability that the negative consequences of climate change will increase is considered to be high.
3. Total score developments = 6.1
4. Uncertainty of projected developments = 1.8
On average, the federal states indicated a moderate level of uncertainty with regard to estimates of future developments in connection with climate change.
5. Compiled relative developments = 0.76
The calculated value of the relative development is very high, indicating that an increase in climate change-related impairments is to be expected and that the potential for countermeasures is limited.

Score for 'Knowledge & uncertainty of projected development Compiled Scores=3 (3.44)

- Moderate knowledge & moderate uncertainty with regard to the characterisation of the stressor 'Climate Change'

Stressor No 9: Invasives

Effects

1. Number of affected populations (including lost populations) = 1.8
The proportion of salmon populations affected by invasive species is not considered to be particularly high on average. However, the estimates of the individual federal states show great variability. A lack of knowledge about the impact of invasive species on salmon was also highlighted by some states.
2. Geographical distribution = 1.6
The analysis of the geographical manifestation of problems caused by invasive species results in an average assessment of low to local manifestation of problems.
3. Negative impact = 1.2
The categorisation of the impact of the stressor 'invasive species' is low in the analysis of the data, with two countries giving a high and very high rating for this item.
Examples of invasive species that could potentially have a negative impact on salmon stocks are Wels catfish and pikeperch (allochthonous in the Rhine basin), rainbow trout, signal crayfish and cormorants. However, the negative impact of these species on salmon is also considered under the stressor 'Predators'.
4. Total score effects = 4.6
5. Knowledge = 2.3
Moderate to poor.
6. Compiled relative effect = 0.38
The impact of the stressor 'invasive species' on salmon stocks is currently estimated to be relatively low.

Developments

1. Potential for effective measures (planned) = 2.9
The potential for action with regard to the stressor of invasive species is assessed as low on average.
2. Likelihood of further negative impacts (due to reduced production capacity or freshwater survival or marine survival) = 1.3
The forecasts regarding a significant deterioration in the adverse effects caused by invasive species in the coming years are classified as rather low.
3. Total score developments = 4.2
4. Uncertainty of projected developments = 2.3
Moderate to high.
5. Compiled relative developments = 0,53
At present, there is little indication that the situation relating to the stressor 'Invasives' will deteriorate significantly in the medium term.

Score for 'Knowledge & uncertainty of projected development Compiled Scores' = 5 (4.67)

- Poor knowledge & large uncertainty with regard to the characterisation of the stressor 'Invasives'.

Stressor No 10: Stocking

Effects

1. Number of affected populations (including lost populations) = 4
As all salmon stocks in Germany are supported by stocking measures, all salmon stocks in Germany are influenced by this stressor.
2. Geographical distribution = 3.1
As salmon are only stocked in certain waters, the geographical distribution of this stressor is estimated to be regional.
3. Negative impact = 1.1
The negative impact on wild stocks is estimated to be low. In Germany, salmon stocking is considered a necessary measure to rebuild stocks, and stocking must continue until self-sustaining salmon stocks have been re-established. As the salmon populations originally present in Germany are completely extinct, it is impossible for stocking to genetically distort autochthonous wild stocks. To date, there has been no evidence of any negative impact of stocking on naturally reproducing salmon and their offspring.
4. Total score effects = 8.2
5. Knowledge = 1.6
Estimated as extensive to moderate.
6. Compiled relative effect = 0.69
The value for relative impact is relatively high, mainly due to the fact that all populations are affected by stocking measures and the geographical distribution is considered to be relatively high.

Developments

1. Potential for effective measures (planned) = 2
On average, the potential for effective measures is rated as moderate.
2. Likelihood of further negative impacts (due to reduced production capacity or freshwater survival or marine survival) = 1.8
The likelihood that salmon stocks will be negatively affected in the coming years, for example by inappropriate stocking practices, is considered low by most federal states.
3. Total score developments = 3.8
4. Uncertainty of projected developments = 1.9
Estimated as moderate.
5. Compiled relative developments = 0.47
There are currently no indications that potential negative influences of the stressor 'stocking' will affect salmon stocks in the medium term.

Score for 'Knowledge & uncertainty of projected development Compiled Scores' = 3 (3.44)

- Moderate knowledge & moderate uncertainty with regard to the characterisation of the stressor 'Climate Change'

Stressor No 11: Predators

Effects

1. Number of affected populations (including lost populations) = 4
Across Germany, all salmon stocks are subject to elevated predation rates.
2. Geographical distribution = 3.6
The issue of over-predation represents a considerable threat to salmon populations across Germany.
3. Negative impact = 3.7
The impact of excessive predation on salmon stocks has been identified as a significant concern by all federal states. The most prominent predators affecting salmon in the Rhine basin include pike-perch, catfish, cormorants and goosanders, while in coastal areas, seals and porpoises are prevalent. Inland, catfish, whose population has exhibited exponential growth over the past two decades, are the only predators capable of consuming adult salmon. In addition to the predators previously identified in the Rhine basin, pike has been identified as a significant predator in the Elbe catchment area, and the otter has been observed to be increasingly present in salmonid waters. The overall impact of these predators is considered to be severely deleterious.
4. Total score effects = 11.2
5. Knowledge = 1
The level of knowledge related to the stressor 'Predators' is rated as good.
6. Compiled relative effect = 0,94
Predators are considered to have the greatest negative impact on salmon stocks in this analysis.

Developments

1. Potential for effective measures (planned) = 2.8
The potential for effective measures against the negative effects of predation is estimated to be low on average.
2. Likelihood of further negative impacts (due to reduced production capacity or freshwater survival or marine survival) = 3.6
The probability of an increase in predation is estimated to be high to very high.
3. Total score developments = 6.3
4. Uncertainty of projected developments = 1.78
The uncertainty regarding the projected developments is estimated to be moderate.
5. Compiled relative developments = 0,79

The value determined for the relative development of the stressor "Predator" is also estimated to be very high. This finding suggests that the potential for countermeasures is considered to be rather low. Furthermore, there are concerns that the negative effects of this stressor could even become even more severe.

Score for 'Knowledge & uncertainty of projected development Compiled Scores' = 3 (2.78)

- Good knowledge & small uncertainty with regard to the characterisation of the stressor 'Predators'.

Stressor No 12: Other

Effects

1. Number of affected populations (including lost populations) = 2.8
In some federal states, salmon stocks are virtually unaffected by stress factors other than the eleven mentioned above. In other federal states, however, many stocks are reported to be negatively affected by other factors.
2. Geographical distribution = 2.7
On average, this results regional distribution of other factors that could affect salmon stocks.
3. Negative impact = 2.2
The negative impact of the stressor 'Other' is assessed on average as moderate. Impact factors mentioned include injuries caused by ship propellers (especially at low water discharges), lack of national structures and funding instruments for the necessary supra-regional research for the reintroduction of salmon into German river basins, and lack of knowledge and inadequate implementation of the requirements of the EU WFD. In general, the comments from some federal states also mentioned pressures under the stressor 'Other' that should be assigned to the stressors 'Water regulations', 'Habitat degradation' and 'Exploitation' and therefore should not be included in the assessment under the stressor 'Other'.
4. Total score effects = 7.7
5. Knowledge = 1.3
6. Compiled relative effect = 0.64

Developments

1. Potential for effective measures (planned) = 3.0
The potential for effective measures with regard to the stressor 'Other' is considered to be low on average.
2. Likelihood of further negative impacts (due to reduced production capacity or freshwater survival or marine survival) = 2.2
The likelihood that additional negative stressors not covered by the above 11 stressors could worsen the situation for salmon is assessed as moderate.

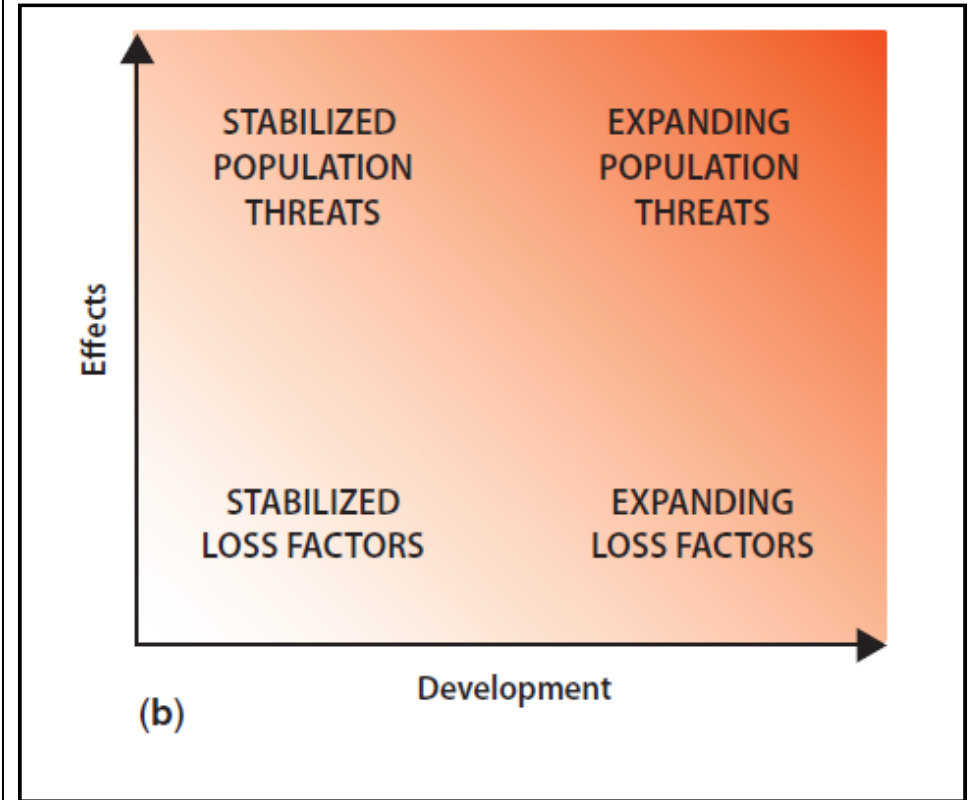
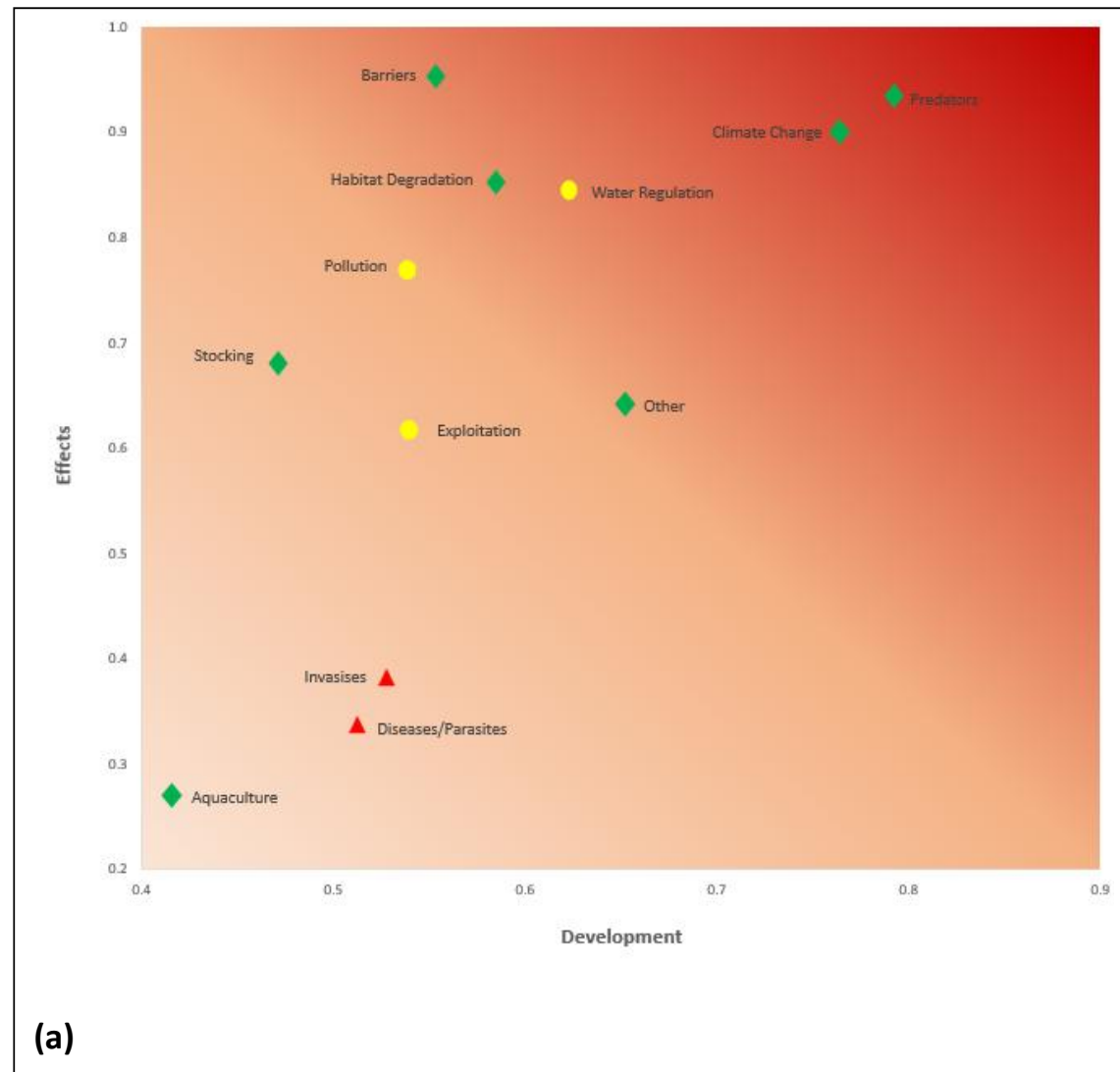
3. Total score developments = 5.2
4. Uncertainty of projected developments = 1.7
Estimated as moderate.
5. Compiled relative developments = 0.65
Perhaps the effect and development of the stressor 'Other' is somewhat overestimated because harmful factors were considered in the analysis that should actually be assigned to stressor categories as 'Water regulations', 'Habitat degradation' and 'Exploitation'.

Score for 'Knowledge & uncertainty of projected development Compiled Scores' = 3

The following assessment should be treated with caution due to the uncertainties in the assessment of the stressor 'Other' mentioned above.

- Good knowledge & small uncertainty with regard to the characterisation of the stressor 'Other'.

Annex 1



- (a) The position of the 12 stressors within the classification system as estimated on average across 9 German federal states. To illustrate this, the level of knowledge about each impact factor and the uncertainty of future developments are represented by the colour of the markings. Green diamond = good level of knowledge and low uncertainty (sum of scores 3), yellow circles = moderate level of knowledge and moderate uncertainty (sum of scores 4), red triangles = low level of knowledge and high uncertainty (sum of scores 5).
- (b) The classification system was developed to assign the various anthropogenic impacts on Atlantic salmon (*Salmo salar*) populations to an effect and development axis. The four main impact categories are shown in the figure, with fluid transitions between the categories. The background colour indicates the severity of the impact, with darker areas representing the most severe impacts.

Annex 2

Table 1: Assessment (ranking) and criteria for classifying the severity of various anthropogenic factors (stressors) along the impact axis (a) and the development axis (b) for the Atlantic salmon stocks in Germany averaged over 9 federal states

(a) Effect axis:	Criteria & Scoring	Pollution	Barriers	Water Regulation	Exploitation	Aquaculture	Habitat Degradation	Diseases / Parasites	Climate Change	Invasives	Stocking	Predators	Other
1. Number of affected populations (including lost populations)	1 = <10%; 2 = >10%; <20%; 3 = >20%; <50%; 4 = >50%	3.8	3.8	3.9	3.4	1.2	3.8	1.3	4.0	1.8	4.0	4.0	2.8
2. Geographical distribution	1 = Local; 2 = Scattered; 3 = Regional; 4 = National	3.1	3.9	3.3	2.4	1.0	3.2	1.4	3.9	1.6	3.1	3.6	2.7
3. Negative impact (due to reduced production capacity or freshwater survival or marine survival)	1 = Small; 2 = Moderate; 3 = Large; 4 = Very large	2.3	3.8	2.9	1.6	1.0	3.2	1.2	2.9	1.2	1.1	3.7	2.2
Sum (maximum score = 12)		9.2	11.4	10.1	7.4	3.2	10.2	4.0	10.8	4.6	8.2	11.2	7.7
Score (0-1)		0.77	0.95	0.84	0.62	0.27	0.85	0.33	0.90	0.38	0.69	0.94	0.64
Knowledge	Extensive = 1, moderate = 2, poor = 3	1.7	1.2	1.6	2.2	1.6	1.6	2.2	1.7	2.3	1.6	1.0	1.3
(b) Development axis:													
1. Potential for effective measures (planned)	1 = High; 2 = Moderate; 3 = Low; 4 = Negligible	2.0	1.9	2.0	2.9	2.2	1.9	2.9	2.8	2.9	2.0	2.8	3.0
2. Likelihood of further negative impacts (due to reduced production capacity or freshwater survival or marine survival)	1 = Small; 2 = Moderate; 3 = Large; 4 = Very large	2.3	2.6	3.0	1.4	1.1	2.8	1.2	3.3	1.3	1.8	3.6	2.2
Sum (maximum 8)		4.3	4.4	5.0	4.3	3.3	4.7	4.1	6.1	4.2	3.8	6.3	5.2
Score (0-1)		0.54	0.56	0.63	0.54	0.42	0.58	0.51	0.76	0.53	0.47	0.79	0.65
Uncertainty of projected development	Small = 1, moderate = 2, large = 3	1.9	2.0	2.0	1.4	1.4	1.9	2.4	1.8	2.3	1.9	1.8	1.7
Stressor Compiled Scores	Axis	Pollution	Barriers	Water Regulation	Exploitation	Aquaculture	Habitat Degradation	Diseases / Parasites	Climate Change	Invasives	Stocking	Predators	Other
Compiled relative effect (0–1)	Effect	0.77	0.95	0.84	0.62	0.27	0.85	0.33	0.90	0.38	0.69	0.94	0.64
Compiled development (0–1)	Development	0.54	0.56	0.63	0.54	0.42	0.58	0.51	0.76	0.53	0.47	0.79	0.65
Knowledge & uncertainty of projected development Compiled Scores	Extensive = 3, moderate = 4, poor = 5 (rounded to integers)	4	3	4	4	3	3	5	3	5	3	3	3