Report of the Meeting of the Stocking Guidelines Working Group

By Video Conference

27 November 2023, 6 & 14 December 2023, 17 January, 14 February and 1 March 2024

1. Opening of the Meeting

1.1 In the absence of a Stocking Guidelines Working Group (the Working Group) Chair, the Secretary opened the meeting.

1.2 A list of participants is contained in Annex 1.

2. Adoption of the Agenda

2. The Working Group adopted the Agenda for the meeting, SGWG(23)03).

3. Formal Appointment of a Chair

3.1 The Working Group appointed Stephen Gephard (USA) as its Chair.

4. Background to the Stocking Guidelines Working Group

4.1 The Chair reminded participants that, to mark the International Year of the Salmon (IYS), a two-day symposium titled 'Managing the Atlantic salmon in a rapidly changing environment – management challenges and possible responses' was held immediately prior to the 2019 NASCO Annual Meeting. The IYS Symposium Steering Committee recommended (see CNL(19)16) that NASCO update its existing Stocking Guidelines in light of:

- the advances that have been made in the last 15 years in understanding genetic effects of artificial population supplementation, i.e. stocking; and
- the conclusions of the 2017 NASCO Special Session on 'Understanding the Risks and Benefits of Hatchery and Stocking Activities to Wild Atlantic Salmon Populations', CNL(17)61.

4.2 Due to the Covid-19 pandemic, the Council of NASCO was unable to consider the recommendations made by the IYS Symposium Steering Committee until its 2022 Annual Meeting. At that meeting, Council agreed that progress on updating the Stocking Guidelines should begin inter-sessionally. Therefore, Terms of Reference for the Working Group, CNL(23)15 (see Agenda Item 5 below), and participation on the Working Group were agreed inter-sessionally.

5. Consideration of the Terms of Reference for the Stocking Guidelines Working Group

5.1 The Working Group considered its Terms of Reference, CNL(23)15, which tasked the Group with:

1. Considering the biological / ecological risks and benefits arising from stocking.

2. Evaluating new approaches and perspectives and / or policies to stocking that could minimise negative effects or risks associated with some hatchery operations.
3. Recommending to Council, for agreement at the 2024 Annual Meeting, an updated document 'Guidelines for Stocking Atlantic Salmon' (Annex 4 of the Williamsburg Resolution) which provides guidance to NASCO's Parties on applying the Precautionary Approach to the authorisation and conduct of any stocking of Atlantic salmon into the wild.

5.2 The Terms of Reference also asked the Group to take into account the following in its deliberations:

- the definition of 'stocking' used in Annex 1 of the Williamsburg Resolution, CNL(06)48;
- Annex 4 of the Williamsburg Resolution CNL(06)48;
- the NASCO Guidelines on the 'Use of Stock Rebuilding Programmes in the Context of the Precautionary Management of Salmon Stocks', CNL(04)55;
- the NASCO Guidelines for 'Incorporating Social and Economic Factors in Decisions under the Precautionary Approach' CNL(04)57;
- the 2017 Theme-based Special Session on 'Understanding the Risks and Benefits of Hatchery and Stocking Activities to Wild Atlantic Salmon Populations', CNL(17)61;
- the 2019 IYS Symposium Report: 'Managing the Atlantic Salmon in a Rapidly Changing Environment – Management Challenges and Possible Responses', CNL(19)16; and
- recent literature on stocking Atlantic salmon (including on management and policy issues).

6. Working Methods

6.1 The Working Group noted that its Terms of Reference included a description of the Working Methods it should use as follows:

- the Working Group should meet inter-sessionally as required, to address its Terms of Reference;
- meetings shall be via video conference;
- the Working Group will decide how to conduct its business to allow it to address its Terms of Reference effectively;
- the Working Group should seek consensus in agreeing its report and in drafting updated 'Guidelines for Stocking Atlantic Salmon';
- in conducting its work the Working Group may wish to communicate with, and request information from experts in the field;
- the Secretariat will provide logistical support and background information to the Working Group, as requested; and
- the Working Group should submit its report to the Council of NASCO for its consideration.

6.2 In advance of the Working Group meeting, the Group considered a large body of relevant publications. The publications that are cited in this report are included in Annex 2. Additionally, the Group invited seven experts in the field to speak to the Group as follows:

- Cathal Gallagher (Inland Fisheries Ireland, Ireland). Dr Gallagher spoke on a fry translocation project on the River Erriff in Ireland. The idea for this project stemmed from a presentation given by Kyle Young at NASCO's 2017 Theme-based Special Session on Hatchery and Stocking activities;

- Ingerid Hagen and Sten Karlsson (Norwegian Institute for Nature Research, Norway): Drs Hagen and Karlsson provided expert genetic advice and spoke to the Group about how Atlantic salmon stocking operations are carried out in Norway and best practice lessons learned from these operations;

- Hannah Harrison (Dalhousie University, Canada): Dr Harrison spoke on the social science aspects of stocking, including important benefits to salmon and people which are neither biological or ecological;

- Richard Kennedy (AFBI, Northern Ireland): Dr Kennedy spoke to the Group on three stocking programmes that had been carried out in Northern Ireland with varying degrees of success, and the lessons learned from these programmes;

- Robert Lennox (Dalhousie University, Canada): Dr Lennox spoke to a paper that he had co-written synthesising the lessons learned from evaluating a number of Atlantic salmon restoration programmes across the North Atlantic; and

- John Whitelaw (Parks Canada, Canada): Mr Whitelaw spoke on the Fundy Salmon Recovery Program, which includes conservation rearing wild smolts in aquaculture cages until their release as adults and live gene-banking.

6.3 The Group agreed that the first two Terms of Reference listed in paragraph 5.1 above would be considered in the report of the meeting. The third Term of Reference would be addressed in the revised guidelines document referred to in paragraph 10.1 below.

6.4 The Group agreed, that for the purposes of the report and proposed revised guidelines, the term 'stocking' should be defined as 'the deliberate release of Atlantic salmon into the wild at any stage of its life cycle for any purpose'. Stocking is typically undertaken for population restoration, population recovery, fishery enhancement, creation of new populations and mitigation.

7. Consideration of the Biological / Ecological Risks and Benefits from Stocking

The Biological and Ecological Risks of Stocking

7.1 The Working Group made the following observations on the biological and ecological risks from stocking in developing the proposed revised guidelines:

a) limited evidence exists in the scientific literature which demonstrates any level of success when it comes to the use of stocking as a restoration method for Atlantic salmon. Lennox *et al.* (2021) reported that of 19 papers identified in the literature reporting on restocking programmes for Atlantic salmon, just two achieved any level of success. Some success was reported in Suldalslagen in Norway (Saltveit *et al.* 2019) and on the Adour River in France (Perrier *et al.* 2014). There is evidence in the literature of other programmes where stocking successfully was used to restore Atlantic salmon, but these instances were always in combination with other restoration efforts (Lennox *et al.* 2021);

b) the evidence generated from four decades of research into the impacts of stocking on Atlantic salmon populations, has prompted the scientific consensus that: *where integrity (i.e. evolutionary and ecological naturalness) of the wild stock is a management priority, stocking should not be considered as a remediation measure* (Hilborne 1992; Blanchet *et al.* 2008; Araki and Schmid 2010; Palme *et al.* 2012; Young 2017; Lennox *et al.* 2021);

c) where a viable population of Atlantic salmon exists, conservation efforts should prioritise the preservation of genetic diversity within wild populations (McGinnity *et al.* 2009). There must be an emphasis on identifying the threats and key drivers which caused the initial population decline (Lennox *et al.* 2021). Relevant restoration actions must be selected in order to resolve issues (Beechie *et al.* 2010). Restoration of habitat quality and quantity should be the initial focus of any attempt to improve Atlantic salmon populations (Giller 2005; Einum *et al.* 2008). Conservation and management interventions should consider wider ecosystem dynamics and address issues such as freshwater connectivity, water quality and habitat degradation (Koed *et al*. 2019). Use of hatchery techniques without addressing the underlying causes of population decline will only serve to mask the need for effective conservation measures (Koed *et al.* 2019, Lennox *et al.* 2021);

d) the empirical evidence shows that the risks associated with stocking outweigh any perceived benefits. Critical links exist between stocking and declines in wild population productivity and between hatchery activity and reduced wild fish individual fitness (Young 2017);

e) the relaxation of natural selection and / or unintentional selection, as a result of broodstock collection and hatchery processes, leads to the evolution of phenotypes that are not well adapted for local prevailing environmental conditions (Bailey *et al.* 2010; Perrier *et al.* 2016; Fraser 2017). The introduction of maladapted individuals, with phenotypes that are misaligned with local conditions, will decrease population growth (Young 2017). Stocked rivers have been seen to consistently demonstrate a reduction in effective population size as a result of the addition of a large number of offspring resulting from a small number of broodstock (Ryman and Laikre 1991; Christie *et al.* 2012; Hagan *et al*. 2020). In instances where hatchery-reared salmon interbreed with wild salmon, genetic introgression can occur leading to loss of local adaptation and reduced fitness of the wild population (Jonsson *et al.* 2019; Bouchard *et al.* 2022). Reduced fitness may compromise the ability of wild populations to adapt to change resulting in a vulnerable population with reduced resilience (McGinnity *et al.* 2009; Ferchaud *et al.* 2018);

f) the environmental conditions and selection pressures in hatchery systems will differ from natural environments and conditions in natal rivers (Fraser 2017). Domestication of salmon as a result of hatchery rearing can lead to epigenetic alteration which can influence morphology, physiology and behaviour (Le Leyur *et al.* 2017; Rodriguez Barreto *et al.* 2019; Venney *et al.* 2023). Differences in morphology, physiology and behaviour between hatchery-reared and wild fish can lead to changes in ecological interactions and can have cascading effects on the wider food web (Orlov *et al*. 2006). The introduction of hatchery-reared fish to wild populations may lead to competition for resources with wild populations, resulting in changes to population dynamics and depletion of wild populations (Jonsson and Jonsson 2006; Brunsdon *et al.* 2017);

g) hatchery-reared fish introduced to wild populations can act as vectors for disease and present risks associated with the introduction of, in some cases novel, pathogens and parasites (McVicar 1997). Hatchery reared individuals tend to be reared in higher densities than wild populations. Higher densities of fish can result in increased susceptibility to pathogen and parasite exposure which may lead to genetic changes in hatchery-reared fish (Fraser 2017); and

h) stocking should only be considered as an emergency measure for a finite period of time (Lennox *et al.* 2021) if there are no wild Atlantic salmon or if the integrity of the wild population is not a management priority. Hatchery effects on wild salmon have been shown to be predominantly adverse across time, species and countries (McMillan 2023). However, in rare cases stocking could be considered in specific instances where the wild Atlantic salmon population is at immediate risk of extirpation (Young 2017).

The Benefits of Stocking

7.2 In addition to considering the biological and ecological benefits of stocking, the Working Group also heard that some hatchery and stocking programmes have been shown to provide or facilitate benefits from a social, cultural and conservation perspective, and such facilities or programmes can engage and educate the public on salmon management and conservation.

The Biological and Ecological Benefits of Stocking

7.3 The Working Group made the following observations on the biological and ecological benefits of stocking in developing the proposed revised guidelines.

7.4 Despite the risks outlined in paragraph 7.1, there are some limited situations where stocking may be beneficial for wild salmon. Stocking may be beneficial where the wild Atlantic salmon population has been extirpated or is at immediate risk of extirpation. There is scientific evidence of stocking programmes achieving a level of success when used in combination with other restoration efforts. Additionally, there may be positive ecological benefits from stocking, for example, reintroduction of marine-derived nutrients into the freshwater environment where salmon have been lost. (Bryson *et al*. 2021).

The Social Aspects of Stocking

7.5 The Working Group noted that stocking may provide or facilitate benefits from a social, cultural and conservation perspective. Hatcheries and stocking activity may engage and educate the public on salmon management and conservation. (Harrison *et al*. 2019).

8. Evaluation of New Approaches to, Perspectives on and / or Policies for Stocking that Could Minimise Negative Effects or Risks Associated with some Hatchery Operations

8.1 The Group noted that the use of hatcheries for Atlantic salmon has been well documented since the mid-1800s and stocking is known to have occurred throughout the Roman Empire (Dunfield 1985). Remarkably, facilities and production cycles have remained largely unchanged since then: adults are artificially spawned; eggs are reared for a period in a hatchery; and juveniles are released at the desired life stage. Only recently, with acknowledgement of the risks posed by these practices, have desired outcomes shifted from maximising the number and size of fish in the shortest period of time, to more conservation-minded objectives. As objectives shift, new approaches that seek to reduce risks have emerged. The Working Group considered a number of these new and emerging approaches and made the following observations:

a) **Smolt-to-Adult Supplementation (SAS)**

This approach seeks to overcome low rates of smolt-to-adult survival, by capturing migrating smolts to be captive-reared until maturation. Adult salmon are subsequently released into the environment where they can spawn naturally. Much less is known about SAS relative to more traditional stocking programmes, however, several distinct risks and benefits have been explored (Fraser 2016 and CNL(17)41); for example, benefits may include: the provision of a predictable input to adult population size; the avoidance of genetic risks associated with captive-rearing at early life-stages and the facilitation of natural mate selection. On the other hand, SAS may reduce marine adaptation and may result in negative carry-over effects on wild fitness. In practice, experimentation with SAS has demonstrated both benefits (e.g. Kidd and Samways 2021) and risks (e.g. Wellband *et al.* 2021) to wild populations.

b) **Novel Rearing Environments and Regimens**

Seeking to mitigate population-specific pressures and / or reduce hatchery-related risks, the use of novel rearing environments and regimens has begun to emerge in the scientific literature. For example, adapting marine aquaculture net cages to grow wild-origin smolts has been used experimentally to support recovery of an endangered population that is limited by low marine survival (Clarke *et al*. 2016). An exploration of aquaculture-aided fisheries enhancement, conservation, and restoration initiatives is scheduled at the 2024 World Fisheries Congress and could shed light on this topic.

c) **Enrichments to the Hatchery Environment**

Environmental enrichment involves the addition of physical complexity to the rearing environment and is intended to reduce the undesirable traits that fish develop in captivity. For Atlantic salmon, efforts directed towards enrichment of the hatchery environment that create more wild-like rearing conditions have demonstrated to result in more 'wild-like' behaviours; for example: increased foraging ability on natural prey; improved migration after stocking; positive impacts on brain physiology and development and enhanced adaptability to novel situations and learning (Naslund and Johnsson 2016).

d) **Translocation of Fry**

This approach moves fry from sites of higher to lower density, to decrease density-dependent mortality and thereby increase overall fry abundance within a catchment. Experimentally, translocated fry have been shown to successfully colonise their new catchment areas, and to have higher survival rates when compared to hatchery-origin fry (Cameron *et al.* 2022).

9. Indigenous Knowledge

9.1 NASCO has acknowledged that the incorporation of Indigenous knowledge into its discussions and policies regarding Atlantic salmon will allow each country to make better informed conservation decisions within their borders. Where stocking occurs in the context of Indigenous peoples' livelihood, land, and rights, an approach that considers both section 4.I. of the proposed revised guidelines for stocking Atlantic salmon' 'Guidelines Relevant to all Stocking Programmes', as well as Indigenous people's connections to, and experience with, Atlantic salmon, should be considered.

10. Recommendations to Council

10.1 The Group considered the current structure of the stocking guidelines as a baseline for its revised stocking guidelines. It felt that the current section on the 'Definition of river classes' was confusing and unnecessary. Instead, the Group agreed that the guidelines should relate to minimising the negative impacts of the specific types of stocking programme. The Group also discussed Section IV of the current guidelines: 'Guidelines for Authorising Stocking'. It felt this was very prescriptive for a NASCO document and agreed that it would not be included in the proposed revised guidelines. The Group developed 'Draft Revised Guidelines for Stocking Atlantic Salmon', SGWG(24)01 (Annex 3), and recommends that Council adopt these Draft Revised Guidelines.

10.2 The Group noted that many involved in Atlantic salmon stocking, or interested in developing such programmes, are not aware of the existing NASCO Guidelines. If the Revised Guidelines are adopted, the Group feels that NASCO must better publicise and promote them if they are to be effective for the conservation of wild salmon. The Working Group would be willing to assist the Secretariat in developing tools or strategies to promote awareness of the Guidelines. The Group recommends that Council accept this offer and ask the Working Group to work with the Secretariat in developing these.

11. Other Business

11.1 There was no other business.

12. Report of the Meeting

12.1 The Group agreed the report of its meeting.

13. Close of the Meeting

13.1 The Chair thanked participants for their contributions and closed the meeting.

Annex 1

Stocking Guidelines Working Group Meeting – List of Participants

Stephen Gephard (Chair)	Fisheries Consultant – United States
Livia Goodbrand	Fisheries and Oceans Canada
Sarah McLean	Loughs Agency – European Union
Steve Sutton (NGO)	Atlantic Salmon Federation Canada
Simon Toms	Environment Agency – United Kingdom
Lovise Marie Vårhus	Norwegian Environment Agency
Emma Hatfield	Secretary, NASCO
Clare Cavers	Assistant Secretary, NASCO
Louise Forero Segovia	Information and Publications Officer, NASCO

Annex 2

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Annex 3

SGWG(24)01

Draft Revised Guidelines for Stocking Atlantic Salmon

1. Introduction

In this document, the term '*stocking*' is defined as 'the deliberate release of Atlantic salmon into the wild at any stage of its life cycle for any purpose'. Stocking is typically undertaken for: population restoration; population recovery; fishery enhancement; creation of new populations and mitigation. Stocking programmes are undertaken to increase the number of salmon returning to a stream. However, an increasing body of scientific evidence concludes that many existing programmes do not achieve their desired objective and, in some circumstances, are likely to have a serious negative impact on any existing populations of wild Atlantic salmon. To mitigate the known risks of stocking practices, NASCO has adopted the following Guidelines for Stocking Atlantic Salmon. This is a revision of previously adopted guidelines.

2. Recognition of the Impacts of Stocking

Deleterious Impacts

The evidence generated from four decades of research into the impacts of stocking on Atlantic salmon populations has prompted the scientific consensus that: **where integrity (i.e. evolutionary and ecological naturalness) of the wild stock is a management priority, stocking should not be considered as a remediation measure**.

The empirical evidence shows that the risks associated with stocking often outweigh any perceived biological / ecological benefits. Risks associated with stocking have been well documented and largely result from the relaxation of natural selection and the impacts of domestication leading to maladaptation and reduced individual fitness. In some cases, stocking has been linked to declines in wild population productivity and reduced wild fish individual fitness. Stocking should only be considered as a last resort, for a finite period of time, where a population of wild Atlantic salmon is at risk of being lost or if the integrity of the wild population is not a management priority.

Beneficial Impacts

Despite the risks outlined above, there are some limited situations where stocking may be beneficial for wild salmon. Stocking may be beneficial where the wild Atlantic salmon population has been extirpated or is at immediate risk of extirpation. There is scientific evidence of stocking programmes achieving a level of success when used in combination with other restoration efforts. Additionally, there may be positive ecological benefits from stocking, for example, reintroduction of marine-derived nutrients into the freshwater environment where salmon have been lost.

Stocking may provide or facilitate benefits from a social, cultural and conservation perspective. Hatcheries and stocking activity may engage and educate the public on salmon management and conservation.

3. Considerations Prior to Stocking

To maximise resilience in salmonid populations in the face of rapid environmental change, it is vital to maintain the genetic diversity and complex life histories of wild populations by ensuring natural reproduction. There must be an emphasis on identifying and remedying the threats responsible for the initial population decline. Relevant restoration actions should address, wherever possible, those reasons on a river-by-river basis. Restoration of habitat quality, quantity and accessibility should often be the initial focus of any attempt to improve Atlantic salmon populations. Conservation and management interventions should consider wider ecosystem dynamics and address issues such as freshwater connectivity, water quality and habitat degradation.

4. Stocking Guidelines

When stocking is proposed, even in light of the precautionary approach stated above, the following guidelines are offered to minimise negative impacts:

I. Guidelines Relevant to all Stocking Programmes

A. In advance of any stocking

1. Research the relevant river system in respect to the history of salmon, past and present distribution, causes for declines and relevant ecological and sociological factors.
2. Identify the status of the stock.
3. If the stock is declining, identify and correct the cause(s) of the population decline (e.g. water quality, habitat, pollution, migratory barriers, fishing).
4. If the corrective measures referenced above are not possible in time to save the population, create a stocking proposal with clear objectives, including a definition of success for that proposal.
5. Discuss the proposed measures with the appropriate authorities to understand the process and secure the necessary permissions.
6. If hatchery stocking appears to be likely in the future, consider the creation of a gene bank prior to total population collapse so native genes can support eventual future stocking programmes.

B. Broodstock selection – to be considered when the use of broodstock is considered to be an acceptable option taking account of the known risks set out above

1. Use broodstock from the same continent of origin (Europe vs North America) as the receiving river.
2. Wherever possible, select broodstock from the river targeted to receive stocking, and, if not possible, the closest relevant broodstock source.
3. Use wild-origin (not hatchery-origin) fish, ensuring negligible negative impact to the wild spawning stock.
4. Select broodstock that are representative of the entire wild population (e.g. size, age, return timing, possible sub-populations from tributaries).
5. Implement a Broodstock Control Programme that screens potential broodstock for fish of aquaculture-origin and non-native strains (using both scale reading and genetic analysis) to reject the use of such fish.
6. Ensure broodstock collection methods minimise damage and stress to help reduce the risk of subsequent disease and mortality. It is imperative that broodstock are held in secure, disease-free facilities and frequently treated with approved and effective chemicals to avoid the loss and deterioration of broodstock prior to maturation and stripping.

C. Broodstock mating

1. Consult with geneticists and maintain consultations to ensure that genetic risks are mitigated on an ongoing basis.
2. Use all available broodstock in mating if considered to be healthy and disease free.
3. The sex ratio of the contributing broodstock should be equal.
4. The contribution of each broodfish to the mating scheme should be equal (e.g. no pooled milt which may result in sperm competition).
5. Consider the use of factorial paired crossings.
6. Adjust the number of broodstock to the size of the existing wild population to avoid reducing the population's effective population size; achieve a Ne / N ratio as close to 2.0 as possible.
7. Employ non-random mating (supported wherever possible by a database of previously genotyped broodstock) to avoid mating of closely related individuals and to increase genotypic diversity.

D. Culture of progeny

1. Maintain pathogen-free conditions.
2. Constantly minimise mortality, which can promote artificial selection of the survivors.
3. For fry, parr and pre-smolts:
   a. Manipulate fish density to reduce antagonistic behaviour, maintain good fin condition, etc.
   b. Increase water velocity to maintain good physical conditioning.
   c. Explore ways of mimicking natural conditions (e.g. substrate, overhead cover, light patterns and photoperiod, and methods of introducing food and possibly introducing natural food) to acclimate the fish to a more natural state that will expedite their transition to the wild.

E. Release of fish

1. Release the youngest possible life stage (i.e. eggs or unfed fry) to minimise hatchery exposure and artificial selection.
2. Avoid release of smolts, which have the longest hatchery residence and also have the highest tendency to stray and enter a non-targeted river that supports wild salmon with a natural genome.
3. Release relevant life-stages into suitable habitat and synchronise releases with appropriate river conditions that mimic the occurrence of the same life stages of wild salmon (e.g. date, water temperature, flows).
4. Avoid releasing fry or parr into areas that are already being utilised by wild salmon.
5. Do not release any life-stage into the wild that has tested positive to known salmon pathogens.
6. Minimise stress during the release stage.

F. Assessment

1. Implement an appropriate monitoring programme that will assess levels of success relative to the stated objectives and support adaptive management.

II. Guidelines for Specific Types of Stocking Programmes

(All guidance listed in section I pertains to all categories listed below)

A. Restoration

This type of programme seeks to re-establish a run of Atlantic salmon in a stream in which the native populations have been lost and there are no extant runs of salmon.

1. Use archived genes if a gene bank has been previously established.
2. Choose a broodstock from the geographically closest wild salmon river that is ecologically similar to the river under restoration.
3. Consider using broodstock from multiple sources as a means to increase the founding population's genetic diversity on which natural selection can act.
4. Specialist genetic advice is needed for the entire programme to guide not only the establishment of the founding population but to guide managers on a broodstock plan and subsequent mating schemes.
5. Use returning adults as broodstock and cease importation of outside sources of fish as soon as the programme can become self-supporting.
6. Once the stock is self-sufficient and genetic viability is secured, cease hatchery operations.

B. Recovery

This type of programme seeks to rebuild stocks of wild salmon that still exist in a stream but are present in low numbers, considered under threat of extirpation and the runs are far below the Conservation Limit of the home streams.

1. Use archived genes if a gene bank has been previously established.
2. Use a broodstock derived from the recovery river, using criteria listed in section 4.I.B.
3. Specialist genetic advice is needed for the entire programme to guide a broodstock management plan and mating schemes.
4. Consider a programme that captures wild-origin parr or smolts and raises them in a hatchery to adult stage as a broodstock supplement to sea-return adults, seeking to minimise the time spent in captivity.
5. Terminate hatchery operations when Recovery Plan goals have been met and allow natural reproduction to continue to rebuild the population.

C. Creation of new runs

This type of programme seeks to create a run of Atlantic salmon in a stream that has never hosted a run of wild salmon. This is typically pursued when a fishway is built around a natural barrier that blocked access to critical upstream habitat.

1. Conduct ecological assessments to determine if the introduction of non-native Atlantic salmon will have unintended consequences for native biodiversity.
2. Follow the guidance outlined in section 4.I. that is relevant to all stocking programmes.

3. Follow the guidance outlined in section 4.II.A. since it also involves stocking a river with no salmon.

D. Mitigation

This type of programme uses the stocking of hatchery salmon as compensation for negative impacts of anthropogenic activities such as dam building and discrete natural / industrial events.

1. Identify and remedy the core issue responsible for the negative impact (see section 3).
2. Careful assessment of the risks and benefits of such a proposed mitigation stocking is needed prior to accepting such a settlement.
3. Proponents should follow the general guidance in section 4.I. but also the relevant guidance in the relevant listed subsections.

E. Fishery enhancement

This type of programme refers to stocking for the purpose of augmenting the production of wild populations with the intent of increasing commercial and / or recreational harvest or recreational angling opportunity. In this instance, stocking would not be considered a conservation measure and NASCO strongly recommends that this type of stocking should not be undertaken where integrity (i.e. evolutionary and ecological naturalness) of the wild stock is a management priority.

1. Alternatives to increasing the harvest or recreational opportunities should be considered and implemented before embarking on a hatchery stocking scheme.
2. For the most part, fishery enhancement stocking is conducted in streams which already have salmon runs. Therefore, if stocking is pursued, guidance in sections 4.I., 4.II.B. and 4.II.D. should be followed.
3. Measures should be undertaken to identify and remove hatchery stock in order to eliminate any spawning of hatchery stock with wild stock.
4. This type of stocking should only be used as a short-term measure.
5. Monitoring should be conducted and if deleterious impacts are observed, stocking should be terminated.

F. Ranching

This type of programme seeks to stock fish (typically smolts) with the sole purpose of harvesting all of the adults when they return to the river to spawn. Ranching normally uses a trap that collects adults and, in some cases, sorts wild and sea-ranched adults. Such programmes are often but not always developed for rivers with no existing wild salmon populations.

1. Stocking guidance in section 4.I. should be followed.
2. Effective imprinting of smolts must be done to minimise subsequent straying of returning adults to adjacent catchments.
3. If the river supports a wild salmon population, a trap should be located downstream of suitable spawning habitat and all returning adult salmon must be trapped and handled. Ranched salmon can be removed for harvest and wild salmon can be released and allowed to proceed upstream.

4. In catchments with wild salmon, ranched smolts should be marked / tagged to allow clear identification of ranched individuals when they arrive at a trap.
5. Monitor the incidence of escapees into the catchment and assess the impact of escapees on the wild salmon population in the catchment.
6. Monitor adjacent catchments that support wild salmon for strayed ranched salmon and if straying is documented, its impact to wild salmon should be assessed.
7. If deleterious impacts to wild salmon are documented in either the natal or adjacent catchments, stocking should be terminated.

5. Overview of New Approaches and Alternatives to Stocking of Atlantic Salmon

The use of hatcheries has been largely unchanged for over 100 years. In this section, new and emerging approaches that may minimise the risks of traditional hatchery practices or provide alternatives to hatchery rearing are identified. NASCO recognises that the techniques described below are novel and potential risks and benefits should be assessed through further scientific research.

- **Smolt-to-adult supplementation (SAS):** this approach seeks to overcome low rates of smolt-to-adult survival by capturing migrating smolts to be captive-reared until maturity. Adult salmon are subsequently released into the environment where they can spawn naturally. SAS may reduce risks by avoiding captive-rearing at early life-stages, and by facilitating natural mate selection. However, SAS may also reduce marine adaptation and result in negative carry-over effects on wild fitness.
- **Novel rearing environments and regiments:** seeking alternatives to the hatchery environment for the production of stocked Atlantic salmon has begun to be explored as a means to reduce risks associated with traditional hatchery environments. For example, adapting marine net pens to grow wild-origin smolt has been used experimentally to stock Atlantic salmon for recovery purposes.
- **Enrichments to the hatchery environment**: this technique involves the addition of physical complexity to traditional hatchery environments. Enriching the hatchery environment may help to reduce risks associated with growing salmon in captivity; i.e. more wild-like rearing conditions may result in more ‘wild-like’ fish. Enriching the hatchery environment can have positive outcomes for captively reared Atlantic salmon, however, it does not eliminate the impacts of time spent in captivity.
- **Translocation of fry:** this approach moves wild fry from sites of higher to lower density to decrease density-dependent mortality, and thereby increase overall fry abundance within a catchment. Experimentally, translocated fry have been shown to colonise their new catchment areas successfully, and to have higher survival rates when compared to hatchery-origin fry.

6. Indigenous Knowledge and Perspectives

NASCO has acknowledged that the incorporation of Indigenous knowledge into its discussions and policies regarding Atlantic salmon will allow each country to make better informed conservation decisions in their borders. Where stocking occurs in the context of Indigenous people’s livelihood, land, and rights, an approach that considers both section 4.I. ‘Guidelines relevant to all Stocking Programmes’, as well as Indigenous people’s connections to, and experience with, Atlantic salmon, should be considered.