

# FishBase Symposium 2022

## Salmonids! / Laxfiskar!

Swedish Museum of Natural History

17 October 2022



## Summary

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## Introduction

After a two year hiatus due to the Covid-19 pandemic, the 18<sup>th</sup> annual FishBase Symposium in Stockholm was held at the Swedish Museum of Natural History in Stockholm on the 17<sup>th</sup> of October 2022. The Symposium is held in Swedish and English, each year with a new, fish-related, theme. Six invited experts give lectures on this year's theme *Salmonids / Laxfiskar*: Steven Weiss (University of Graz, Austria) talked about the species diversity, biogeography, and conservation status of graylings (*Thymallus*); George R. Pess (NOAA, USA) discussed how local ecosystems had responded to the removal of the Elwha River dams, Washington State, USA; Sarah J. Salisbury (University of Edinburgh, UK) showed how one can glean evolutionary insights from the study of sympatric salmonid morphs; Gunnar Öhlund (SLU, Sweden) explained how the pike (*Esox lucius*) appears to be driving incipient speciation in whitefish (*Coregonus*) populations in northern Sweden; Johan Östergren (SLU, Sweden) detailed the human impact on the genetic diversity of Atlantic salmon (*Salmo salar*); and Jernej Bravničar (University of Ljubljana, Slovenia) talked about how new molecular genetics tools are producing a new understanding of the biogeography and phylogeny of European trout (*Salmo trutta* with allies) and grayling (*Thymallus thymallus*), with particular focus on salmonid conservation and management in the Soča River.



*The 194 participants listened to six invited experts, who gave lectures on different aspects of salmonid fish. Videos of the lectures are available at FishBase Sweden's YouTube channel and the homepage of the Swedish Museum of Natural History.*



## Moderator: Bo Delling

*Swedish Museum of Natural History, Sweden*

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Bo Delling is since 2020 the curator of fishes and herptiles at the Swedish Museum of Natural History. His PhD thesis, defended in 2003, focused on species-level systematics and phylogeny of *Salmo* – particularly the more southerly distributed trouts found in rivers and lakes around the Mediterranean Sea.

Bo Delling spent several years with the big book project covering the Swedish fish fauna, *Nationalnyckeln*, and his recent contributions to science within the field of Salmoniforms include studies of sympatric spring- and autumn-spawning ciscoes *Coregonus albula* in Swedish lakes.

## Steven Weiss

*University of Graz, Austria*

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Steven Weiss is currently an Associate Professor at the Institute of Biology in Graz, Austria, where he has been working since 2002. He received his doctorate degree at the University of Agriculture in Vienna Austria in 1997 and held two post-doctoral research positions, one in Vienna, and one in Portugal, before coming to Graz. He was born in the United States of America, where he received both his bachelor and master's degrees. He has broad interests in evolution, population genetics, phylogeography and conservation, primarily involving freshwater ecosystems, with a special focus on salmonid fishes. He teaches a number of courses in ecology, evolution and statistics. Steven Weiss is the Eurasian focal point authority for salmonid

fishes for the IUCN and has been actively engaged with both government and non-governmental organizations campaigning for the protection of free-flowing rivers.

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### SPECIES DIVERSITY, BIOGEOGRAPHY AND CONSERVATION STATUS OF GRAYLINGS (*THYMALLUS*) THROUGHOUT THEIR RANGE

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I will discuss and outline the present state of knowledge concerning the number of recognized species of grayling (*Thymallus*) throughout their European, Asian, and North American range.

Graylings are perhaps one of the less studied genera of salmonid fishes, a family of fishes well-known for their value in commercial and sport fisheries, as well as high ecological role in cold, temperate freshwater systems. In recent years, a better understanding of their diversity, especially in Asia has developed, largely through the complimentary use of state-of-art genetic data acquisition and traditional phenotypic observations and morphological measurements. To date, our data support the recognition of 13 grayling species, whereby there is potential for several unrecognized species, and some taxonomic uncertainties or controversies.

In this talk published mitogenome based phylogeny will be combined with unpublished ddRAD sequence data to provide a robust phylogenetic overview of the genus. A few instances of cyto-nuclear discordance and its causes will be presented. For Europe, a more detailed view of our current knowledge on the biogeographic history will be discussed, along with a quick view into ongoing similar analysis for the Asian and North American range of the genus. The conservation status of each species will be presented along with a range of open questions on the evolutionary history and systematic diversity of the genus as a whole, as well as a few enigmatic species or regions of grayling range that have not yet been adequately explored.

## George R. Pess

*United States National Oceanic and Atmospheric Administration (NOAA) Northwest Fisheries Science Center (NWFSC), USA*

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George Pess has worked in fisheries since 1989. His primary research interest has been the examination of natural and land-use effects on salmon habitat and salmon production. George is program manager for the watershed program at the United States National Oceanic and Atmospheric Administration (NOAA) Northwest Fisheries Science Center (NWFSC). He is also an affiliate professor at the University of Washington School of Aquatic and Fishery Sciences. George has conducted research on historic and current land use impacts on salmon habitat and production, the influence of wood in forested stream channels, and how landscape characteristics and land use affect salmon abundance. George's main current research projects include the ecosystem response to the removal of the Elwha River

dams. George has an A.B. in Economics and Environmental Science (Bowdoin College 1987), an M.S. in Forest Science (Yale University 1992), and a Ph.D. in Aquatic and Fishery Sciences (University of Washington, 2009).

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### ECOSYSTEM RESPONSE TO THE REMOVAL OF THE ELWHA RIVER DAMS, WASHINGTON STATE, UNITED STATES OF AMERICA

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Worldwide stream and watershed restoration efforts cost billions annually. These projects are typically local-scale activities that do not have a measurable effect on ecosystem function or services. One ecosystem restoration technique that can have a large-scale effect is dam removal. This single action allows for the re-connection of ecosystem processes such as upstream and downstream organism movement, the rapid transformation from lentic to lotic conditions in former reservoirs, rapid shifts in community structure and food webs, and accelerated habitat creation through sediment deposition.

We present results from the Elwha River, where the largest dam removal ever undertaken resulted in measureable ecosystem changes. The release and subsequent downstream transport of tens of millions of metric tonnes of sediment from former reservoirs has resulted in the transformation and rebuilding of estuarine and riverine habitats. The resumption of free passage for aquatic organisms has re-established anadromous fishes to areas that have been void of such species for 100 years, prompting rapid increase in salmonid life history diversity. Short-term changes due to large changes in sediment supply resulted reductions in Chinook salmon productivity but has recently rebounded. Following dam removal, marine derived nutrients increased, entered foods webs and altered the migration patterns and fecundity of an aquatic song bird. Our results demonstrate the critical importance of maintaining longitudinal connectivity for maintaining watershed processes and ecosystem services.

## Sarah J. Salisbury

Roslin Institute, University of Edinburgh, UK

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Sarah Salisbury is a Research Fellow at the Roslin Institute, University of Edinburgh working on investigating the genetic underpinnings of differences in sea lice resistance among salmonids with Dr. Diego Robledo. She completed her BSc (Honours) at the University of Guelph (Canada) before completing her MSc at Dalhousie University (Canada) with Dr. Daniel Ruzzante on the population genetics of Longnose Suckers (*Catostomus catostomus*) in Labrador, Canada. Eager for another chance to fly around in a helicopter sampling fish, she signed up with Dr. Ruzzante for a PhD investigating the evolutionary genomics of Arctic Charr (*Salvelinus alpinus*) in Labrador, Canada. This work further grew her appreciation of salmonids for their usefulness as models of evolution as well as their undeniable economic, cultural, and ecological value. Her

research interests involve investigating salmonids and other fishes using genomic tools to help improve their lives and those of the people that rely on them.

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### EVOLUTIONARY INSIGHTS FROM SYMPATRIC SALMONID MORPHS

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Sure salmonids are tasty and fun to catch, and of course culturally and economically important to many communities around the world, but in comparison to the kaleidoscope of colours displayed by tropical reef fishes, aren't they a bit dull? Upon closer examination however, the stunning degree of within-species trait variation found in salmonids reveals them to be some of the most variable vertebrates on the planet. This variation can occur in the form of "morphs" that differ strikingly in their appearance and behaviour yet frequently occur in the same (sometimes exceedingly small) lake.

Because these co-occurring (sympatric) morphs have independently evolved multiple times over a short evolutionary period, they can be thought of as natural replicates of evolution. These morphs therefore offer a powerful model for investigating fundamental evolutionary processes relevant across the tree of life including incipient phenotypic differentiation and reproductive isolation.

In this talk, I will provide an overview of the literature on the genetic underpinnings of sympatric morph differentiation within salmonids, presenting case studies from multiple species including my work on Arctic Charr (*Salvelinus alpinus*) in Labrador, Canada. My particular focus will be on the influences of historical secondary contact events and the multiple potential molecular mechanistic levels underlying consistent sympatric morph differentiation. By the end of my talk, I hope to convince you that salmonids have enormous potential to help us uncover the genomic mechanisms of speciation.



## Gunnar Öhlund

*Sveriges Lantbruksuniversitet (SLU), Sverige*

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Gunnar Öhlund är forskare på institutionen för vilt, fisk och miljö på SLU i Umeå. Hans forskningsintressen inkluderar artbildningsprocesser i nordliga fiskpopulationer, effekter av mänsklig störning på akvatiska ekosystem och förvaltning av invasiva arter. Speciellt fascinerad är han av hur samverkande ekologiska och evolutionära processer bygger upp födovävar i nordliga sjöekosystem.

I tätt samarbete med förvaltning och lokala fiskare driver han för närvarande ett forskningsprojekt som fokuserar på bildandet av, och hot mot, inomartsdiversitet hos laxartade fiskar. Tillsammans med flera länsstyrelser driver han också ett projekt som syftar till att utrota invasiv bäckröding.

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### ARTBILDNING I NORRLÄNDSKA SIKBESTÅND – ORSAKER OCH KONSEKVENSER

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Laxartade fiskar bildar ofta små- och storvuxna ekotyper i samma sjö, ett fenomen som har fascinerat människor i århundraden. Vår förståelse av varför den här artbildningsprocessen sker är fortfarande begränsad, bland annat på grund av att det är svårt observera den direkt i naturen.

I det här föredraget kommer jag att presentera resultat från vår forskning om artbildningens orsaker och konsekvenser i norrländska siksjöar. Vi har försökt ta reda på hur omgivande faktorer i sjömiljön kan driva sikbestånd till att dela upp sig i små- och storvuxna ekotyper och hur detta i sin tur påverkar sjöarnas ekosystem. Våra resultat visar att en stor rovfisk spelar en nyckelroll i den här historien och att sikens artbildning kan orsaka ytterligare storleksförändringar också hos andra laxartade fiskar.

## Johan Östergren

*Sveriges Lantbruksuniversitet (SLU), Sverige*

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Johan Östergren är docent i biologi inriktning ekologi vid institutionen för akvatiska resurser, SLU Aqua. Hans forskning fokuserar på främst laxfiskars ekologi och populationsstruktur samt effekter av mänsklig påverkan på olika fiskbestånd, till exempel av vattenkraft, fiskutsättningar och fiske. Johan använder främst genetik, men även telemetri, i forskning och utvärderingar. Målet är att integrera forskningsresultat i en långsiktigt hållbar förvaltning av våra naturresurser, bland annat genom vetenskaplig rådgivning och samverkan med olika samhällsaktörer, som myndigheter, industri och olika organisationer. Johan doktorerade i biologi med inriktning fiskbiologi 2007 vid Institutionen för vilt, fisk och miljö, SLU, gjorde därefter en postdoc på IIASA, Österrike, och är sedan 2011 biträdande avdelningschef på

Sötvattenslaboratoriet, SLU Aqua, Drottningholm. Han är också föreståndare för Centrum för vattenkraft, miljö och samhälle, VMS, med syfte att bidra till kunskapsbehovet kopplat till miljöomprövningen av svensk vattenkraft.

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### LAXEN OCH MÄNSKLIG PÅVERKAN PÅ DESS GENETISKA MÅNGFALD

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När inlandsisen drog sig tillbaka följde laxen efter och koloniserade vattendragen som bildats i Sverige. Sedan dess har laxen utvecklats och anpassats till olika miljöer som finns idag, från Torneälven i norr till Mörrumsån i söder, och bildat genetiskt skilda bestånd. Laxen var tidigt en viktig resurs, inte minst syns det i hållristningar i Nämforsen i Ångermanälven. Så viktig var den att Kung Gustav Vasa belade laxen med skatt på 1500-talet. I Östersjön fanns ca 100 olika laxpopulationer, men idag finns bara ca 30 naturligt reproducerande laxstammar kvar. Den största anledningen till detta är utbyggnaden av vattenkraften. Även västkustlaxen påverkas av vattenkraften, men här finns även andra yttre hot som invandrad norsk odlad lax och puckellax. Som kompensation för förlorad livsmiljö orsakat av vattenkraften odlas och frisläpps stora mängder laxungar. Den onaturliga befruktningen och uppväxten i odlingsmiljö gör att de gener som är nödvändiga för att klara sig i naturen missgynnas, och laxar födda i odling har sämre förmåga att klara sig i naturen. Om dessa blandar sig med vilda laxar riskeras även de vilda att få sämre förutsättningar att klara sig.

I denna föreläsning kommer jag att berätta om vilka genetiska effekter odling och utsättning av lax kan få för den genetiska mångfalden. Bland annat har analyser av upp till 100 år gamla laxfjäll gett insyn i den historiska genetiska sammansättningen i olika laxälvar och av genetiska förändringar med tydliga kopplingar till fiskutsättningar.

## Jernej Bravničar

University of Ljubljana, Slovenia

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Nejc Bravničar, as he is commonly called, hails from Ljubljana, Slovenia. During his short career, he has been firmly rooted in the Department of Animal Science at the Biotechnical faculty, University of Ljubljana. In 2021, he completed his PhD in conservation genomics and is currently a researcher at his alma mater as a member of the Balkan Trout Restoration Group. His focus is phylogenetics, population genetics and conservation genetics, to which he recently added the suffix -genomics. Using these tools, he aims to determine selection pressures in different environments, answer management questions, and study the effects of potential translocations on existing populations. His main research focuses on salmonid species in the Balkan Peninsula and beyond.

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### EVOLUTIONARY AND PHYLOGENETIC ASPECTS OF TROUT AND GRAYLING IN EUROPE IN THE GENOMIC ERA, WITH HIGHLIGHT ON SALMONID CONSERVATION AND MANAGEMENT IN THE SOČA RIVER

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Salmonids are considered "recent" colonizers of the European continent when compared to the Cypriniformes. Historically thoroughly studied, mostly because of economic importance, their taxonomy and phylogeny are constantly under review. As new research tools are applied, new hypotheses emerge that shift the phylogenetic relationships among the taxa under study.

The "true" phylogenetic signal is naturally blurred by periodic range shifts, local extinctions, and recolonizations, while at the same time it's severely compromised by constant translocations and intensive population management. The genomics era has seen the discovery of numerous tools, including those that allow us to analyze museum specimens, thus providing unique opportunity to study the populations before major translocations and subsequent hybridizations. However, despite the great utility of genomic tools for taxonomy and phylogeny, the following questions arise: How can the findings of genomics be related to findings of genetics and morphology; can phylogenomics be the holy grail of taxonomy; what pitfalls can be expected in future studies?

Because the peri-Mediterranean basin harbors great trout diversity, it may prove to be a perfect testing ground for using genomic tools to uncover trout taxonomy and phylogeny and answer these questions. In the talk we will address the discrepancies observed when considering phylogeny at different levels of resolution within European salmonids, focusing on the position of *Salmo marmoratus*, a species whose most important morphological trait could be considered plesiomorphic in certain cases. In addition, we will address the tools that can be used for the

conservation management of the species, while trying to get by the fact, that trout have a major ecological advantage over grayling in terms of conservation efforts. This disadvantage complicates the possibilities for genetic rescue of the highly endangered Adriatic grayling (*Thymallus thymallus*) in the fly-fishing paradise of Soča river, but genomics will provide the basis for its restoration, hopefully as successful as was that of the marble trout.





## Photos from the Symposium



*Participants study informational material*



*Fruit break mingle*



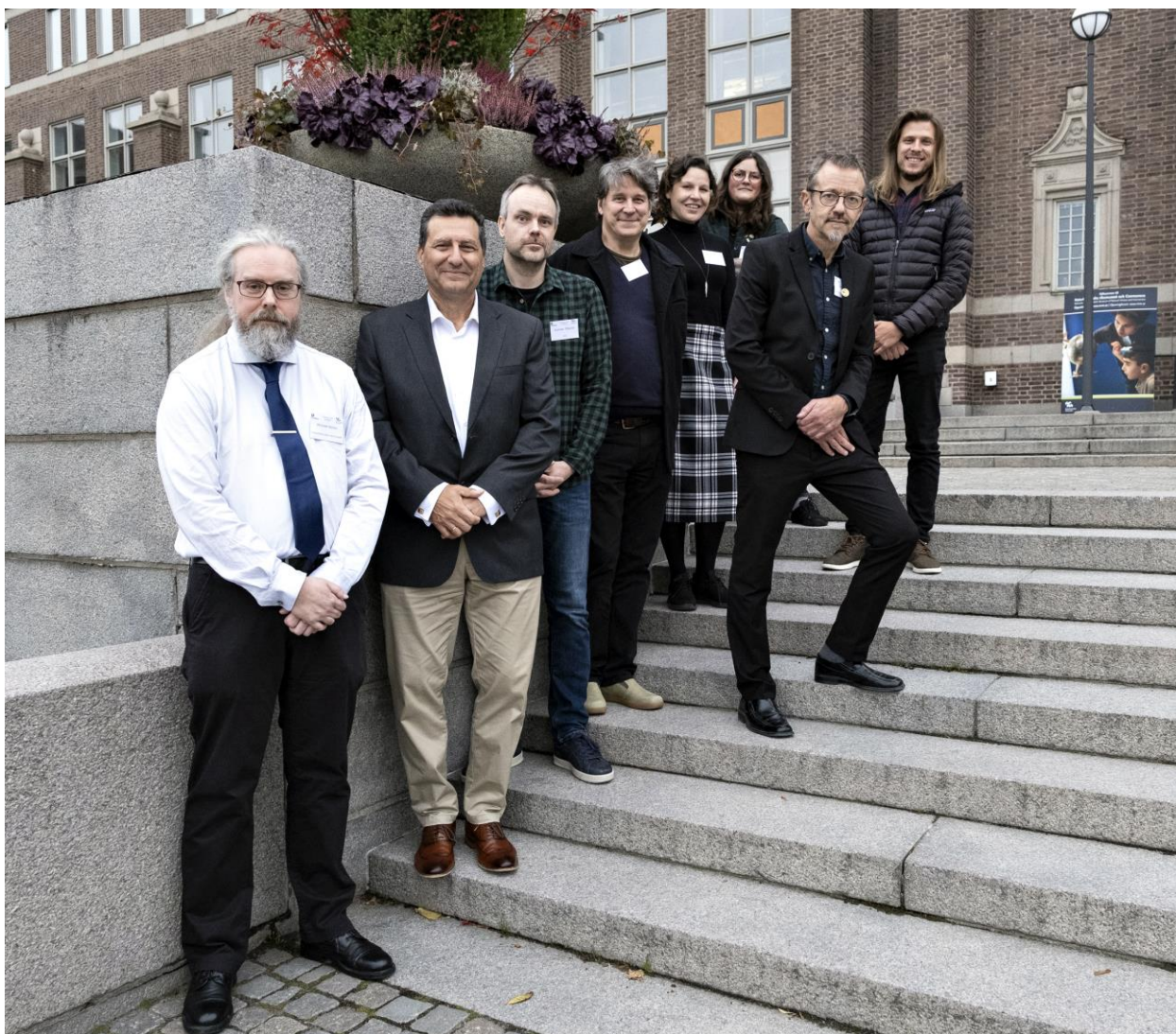


*There was a well-attended poster session at the Symposium*



*Coffee break mingle*





**Organizers and speakers of FishBase Symposium 2022.** From left: Michael Norén, George R. Pess, Gunnar Öhlund, Steven Weiss, Sarah J. Salisbury, Andrea Hennyey, Bo Delling, and Jernej Bravničar.

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*FishBase Sweden would like to thank all speakers and participants for making FishBase Symposium 2022 a success, and hope to see you all again next year at FishBase Symposium 2023!*

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## FishBase Symposium 2022 — *Laxfiskar!*

### Program

- 09:00 - 09:30    Registrering, kaffe och smörgås  
Moderator: **Bo Delling**, Naturhistoriska riksmuseet
- 09:30 - 09:35    Inledning, **Michael Norén**, FishBase Sverige
- 09:35 - 10:20    **Steven Weiss**, University of Graz, Österrike: *Species Diversity, Biogeography and Conservation status of graylings (Thymallus) throughout their range.*
- 10:20 – 10:50    Fruktpaus
- 10:50 – 11:35    **George R Pess**, National Oceanic and Atmospheric Administration: *Ecosystem response to the removal of the Elwha River dams, Washington State, United States of America.*
- 11:35 – 12:20    **Sarah J. Salisbury**, University of Edinburgh, Storbritannien: *Evolutionary Insights from Sympatric Salmonid Morphs.*
- 12:20 – 13:30    Lunch
- 13:30 – 14:15    **Gunnar Öhlund**, Sveriges Lantbruksuniversitet, Sverige: *Artbildning i norrländska sikbestånd – orsaker och konsekvenser.*
- 14:15 – 15:00    **Johan Östergren**, Sveriges Lantbruksuniversitet, Sverige: *Laxen och mänsklig påverkan på dess genetiska mångfald.*
- 15:00 – 15:30    Kaffepaus
- 15:30 – 16:15    **Jernej Bravničar**, University of Ljubljana, Slovenia: *Evolutionary and phylogenetic aspects of trout and grayling in Europe in the genomic era, with highlight on salmonid conservation and management in the Soča River.*
- 16:15 – 16:20    Avslutning

Tid: Måndag 17:e oktober 2022, 09:00 – 16:20.

Plats: Stora hörsalen, Naturhistoriska riksmuseet, Frescativägen 40, Stockholm.



## FishBase Symposium 2022 — *Salmonids!*

### Programme

- 09:00 - 09:30     Registrering, kaffe och smörgås  
Moderator: **Bo Delling**, Swedish Museum of Natural History
- 09:30 - 09:35     Opening, **Michael Norén**, FishBase Sweden
- 09:35 - 10:20     **Steven Weiss**, University of Graz, Austria: *Species Diversity, Biogeography and Conservation status of graylings (Thymallus) throughout their range.*
- 10:20 – 10:50     Fruit break
- 10:50 – 11:35     **George R. Pess**, National Oceanic and Atmospheric Administration, USA: *Ecosystem response to the removal of the Elwha River dams, Washington State, United States of America.*
- 11:35 – 12:20     **Sarah J. Salisbury**, University of Edinburgh, United Kingdom: *Evolutionary Insights from Sympatric Salmonid Morphs.*
- 12:20 – 13:30     Lunch break
- 13:30 – 14:15     **Gunnar Öhlund**, Swedish University of Agricultural Sciences, Sweden: *Artbildning i norrländska sikbestånd – orsaker och konsekvenser.*
- 14:15 – 15:00     **Johan Östergren**, Swedish University of Agricultural Sciences, Sweden: *Laxen och mänsklig påverkan på dess genetiska mångfald.*
- 15:00 – 15:30     Coffee break
- 15:30 – 16:15     **Jernej Bravničar**, University of Ljubljana, Slovenia: *Evolutionary and phylogenetic aspects of trout and grayling in Europe in the genomic era, with highlight on salmonid conservation and management in the Soča River.*
- 16:15 – 16:20     Symposium Close

Time: Monday, 17<sup>th</sup> October 2022, 09:00 – 16:20.

Place: Main Auditorium, Swedish Museum of Natural History, Frescativägen 40, Stockholm.