River Herring Technical Expert Working Group (TEWG)

Climate Change Subgroup Webinar/Conference Call
August 14, 2014
11:00am - 1:30pm

Summary

I. Overview

The Climate Change Subgroup of the River Herring Technical Expert Working Group was established to "consider the impacts of climate change and climate variability on river herring rangewide (including freshwater)" in order to help contribute to the expected products of the TEWG. Janet Nye and Mike Alexander, co-chairs of the Climate Change Subgroup, convened a call on August 14, 2014, to continue to hear and discuss the latest research on climate change science. This included a continuation of the previous Climate Change Subgroup call which was focused on the impact of physical factors based on river herring and other anadromous species derived from observations, and an examination of future changes from model projections. The draft agenda for the meeting included topics such as: 1) speaker presentations; 2) discussion of presentations, and 3) river herring research needs. This meeting summary includes the primary discussion topics and outcomes to contribute to future TEWG discussions. The information provided below reflects individual expert opinion and not consensus.

II. Key Topics

The following is a list of individual expert opinions provided by Climate Change Subgroup members or the public on various overarching topics. Some ideas have been combined where appropriate.

- Speaker's conclusions (full presentations available at the website below under "Meeting Materials," which includes a complete list of authors) and individual comments include:
    - *Simulations of Allis shad (Alosa alosa) distribution in response to climate change* presented by Thibaud Rougier (IRSTEA, University of Bordeaux, France). Climate change impact on Allis shad distribution (and other diadromous fish) were studied using Empirical Species Distribution Models (SDMs) (correlative approach) (Lassalle, PhD, 2008) and Mechanistic Species Distribution Model (Rougier, PhD, 2014). The best variables explaining the distribution for the SDMS included the longitude, the summer temperature at the mouth, and the watershed area (Lassalle et al., AFS 2009; Lassalle and Rochard, GCB 2009). However, many ecological processes are at the origin of an observed distribution and these processes are captured (but ignored) in empirical species distribution models (Kearney, Oikos 2006; Kearney and Porter, Ecol. Lett. 2009). Therefore,

a mechanistic modelling approach approach was developed aiming at assessing diadromous fish local persistence, global persistence and potential evolution of their distribution area in the context of climate change using the GR3D model (Rougier et al., Ecol. Mod. 2014)

The GR3D model covers the entire life cycle of any anadromous species, including information such as six biological processes with different level of complexity in terms of parameters number (total of 42 parameters; 22 are set parameters). The GR3D model requires a lot of information for input on a species. The model could help to understand the evolution of the distribution area of the species between 1900 and 2000 and could give some clues about its evolution until 2100 (Rougier et al., in prep). Preliminary results indicate that the GR3D shows good capacities to reproduce the 1900 observed distribution (Rougier et al., in prep). Additionally, simulations until 2100 strongly suggest that Allis shad could be able to cope successfully with the ongoing climate change and the results were consistent with the empirical modelling approach (Lassalle and Rochard, GCB 2009). Ongoing modeling approaches include: 1) local scale: gironde population dynamics (Rougier et al., ICES JMS 2012); and 2) large scale using both empirical approaches (Lassalle et al., PhD 2008) and a mechanistic approach with the GR3D model (Rougier et al., Ecol. Model. 2014).

A long term conservation plan could be considered which could possible include include a restocking program in the Gironde basin (a program already exists in the Rhine river, Germany, since 2008). There are ongoing field and experimental studies including: 1) large scale study on allis shad homing using otoliths and genetics (Martin et al., in prep); 2) use of bycatch survey to model marine shad distribution (Trancart et al., in press); and 3) Experimental study on juvenile survival under different thermal and oxygen concentration conditions (Lambert et al., in prep).

- Comments: The Lynch et al. (2014) study used marine temperatures to project future river herring abundance and habitat, however, the mechanism is unknown as compared to the Rougier study which used temperature at the mouths of rivers and it is thought that the mechanism behind this temperature effect is that it cues the spawning run. A sensitivity analysis was done on the GRD3 model to calibrate it with the data. Climate change was not responsible for the collapse in this species, but rather other factors such as pollution, fisheries, and dams. Although climate change does not appear to be a large threat for this species, information from climate studies can help determine where to restock and where to put conservation efforts.

- *Ongoing work on climate in the Northeast*, presented by Jon Hare (NOAA/NMFS/NEFSC). Temperatures on NEUS shelf are increasing. A

number of other parameters are changing as well. Alewife distribution has changed substantially in past 45 years as in the last 1960's they were in surveys found from North Carolina to south of Nantucket, and in the late 2000's they were found from Hudson Canyon into the Gulf of Maine (http://www.nefsc.noaa.gov/epd/ocean/MainPage/ioos.html). Additionally, alewife were included in the 24 of 36 fish stocks shifted poleward /deeper, and had the greatest change (Nye et al. 2009). Empirical species distribution models have been projected using climate forecasts (e.g., niche model of habitat in Hare et al., 2012). Future changes have also been projected through coupled biological-climate models (e.g., relative abundance in Lynch et al., 2014).

Quantitative approaches have been used for a number of species, but based on the number of species where information is still needed, it will take a number of years before we have an understanding of the direct effect of climate on resource species. As a result, a qualitative NMFS' Northeast Fisheries Climate Vulnerability Assessment is ongoing to consider 79 species by combining components of exposure and sensitivity to evaluate overall vulnerability. An outcome of the assessment will be a matrix showing the vulnerability by species group. Preliminary information indicates that exposure to climate change in NEUS is high to very high. Additionally, sensitivity is higher for diadromous and shellfish, and lower for groundfish and pelagics. The NEFSC received funds to develop habitat models using both fishery dependent and independent data to predict river herring and shad distribution in relation to Atlantic herring and Atlantic mackerel distribution. The models might indicate that their overlap can be predicted. These empirical species distribution models can be used a number of different ways. It is important to highlight that there is a regional specific request for proposals from NOAA's Climate Program Office where full proposals should be submitted in September.

- Comments: The shell fish are highly vulnerable to climate change because of ocean acidification, and the diadromous are vulnerable because of their complex life histories and climate change factors. There were questions on calibrating the model used in the river herring marine climate change study, and whether the data reflect the distribution of the species. Data is needed to calibrate species distribution models, and various sources of data were used for the model (e.g., fishery independent data, various climate indicators such as bottom and sea surface temperature and salinity). The river herring model seems to accurately capture historical trends in marine distribution; it is based on the mean climatology so it does not capture

the annual dynamics and species distribution. Considering how the phenology changes with timing of the survey is important (e.g., alewives appear to be moving north, but is it because the southern fish are moving into estuaries earlier?). It would be important to look at the historical distribution of river herring in watersheds.

River herring studies have included the marine phase (Lynch et al., 2014) and freshwater (Tomassi et al., In review), but the next step is to consider the whole life cycle. A mechanistic model is an excellent way forward to bring the marine phase, freshwater phase and the connection between the two. Phenology and physiology is important but age-specific information is also important to consider. Individual drivers (e.g., temperature) and interaction between drivers (e.g., acidification and temperature) should also be investigated. Accordingly, the GRD3 model or similar should be considered for river herring. The subgroup should review these to determine what information is available, demonstrate data gaps, and help determine what is needed. Parameter uncertainty should not dissuade the subgroup from considering mechanistic models, as this can help focus on what is uncertain based on the outcome of the model.

- *A review of river herring life history particularly their estuarine phase; stable isotope research update*, presented by Karen Wilson (U. of Southern Maine). (Additional information on this presentation, including applicable references on the information presented can be obtained by contacting the author.) Alewives in Maine can be stranded in lakes especially if there is a dry August or September. After the rainfall there is a huge flushing event, and many river herring are seen ready to migrate (older fish are seen first and then the young follow). A compilation of studies was reviewed which documented temperature in terms of spawning, migration, incubation, hatching and larval (e.g., larval survival of alewife and blueback herring is minimal above 28° C which has implication for river herring in lakes). (NOTE: this information was provided at the 2012 NMFS River Herring Climate Change Workshop and can be found at http://www.greateratlantic.fisheries.noaa.gov/prot_res/CandidateSpeciesProgram/ClimateChangeWorkshop/Day%201/RH%20CC%20Workshop%20KWilson.pdf)[1]. This information could be updated with recent studies (e.g., Velotta et al., 2014; also see July 21, 2014, TEWG Climate Change Subgroup

[1] Table and additional information found in the NMFS River Herring Climate Change Workshop report; http://www.nero.noaa.gov/prot_res/CandidateSpeciesProgram/sswpdocs/RIVER%20HERRING%20CLIMATE%20CHANGE%20WORKSHOP%20REPORT_122712.pdf

summary at the below noted website). Alewife and river herring tend to be fairly tolerant to changes of salinity, and there is a lot of flexibility in their movement. It is uncertain whether their prey are similarly tolerant to these changes.

Estuaries, rivers and bays are important to river herring based on acoustic tagging of post-spawning alewives in the Penobscot River. A variety of ages and sizes were found in the estuary during the entire study period. Fish also moved from the upper river to the estuary area and stayed a few weeks before heading out to sea. River herring have a longer residency in estuaries in Maine than originally thought. Diet studies (using stable and carbon isotopes) from NMFS trawl samples indicate that river herring are feeding in the estuaries. Also, smaller fishes have less of a marine signal than the large adults (e.g., fish come from offshore to feed in the estuaries, and the younger fish may be moving in and out of the estuaries to feed).

Nearshore marine distribution from trawl surveys (Maine DMR, unpublished data) can show distribution (e.g., fish have a strong shore distribution and there are many young-of-year; there is an offshore movement in spring and an inshore movement in the fall). However, adults are not sampled in the trawls. There is an increasing trend in near shore trawl survey, and the temperature are currently within the comfort zone for alewives. The fish are much smaller at age than the older data in the 1960s for the Penobscot River.

- Comments: Surveys are conducted at same time each year and these may not correspond to changing run times. The estuaries appear to be important but we know little about the dynamics in those estuaries. There is little information on how climate change impacts food sources. Alewives are growing rapidly in the estuaries. The acclimation timing for river herring transitioning from marine to estuarine to river may not be too much. Although there is in information on how long adults spend before moving up into those rivers, it is assumed they are amassing waiting for the preferred temperatures. Based on information in the Penobscot River, they have the ability to move back out to the salty areas quickly (e.g, after a big weather event). Further studies are needed to see if fish are moving back and forth in the Penobscot River or if there two different populations. Additional studies will include any differentiation between marine and freshwater (e.g., littorial zone) isotopes; this will be useful to look at juveniles migrating out, but information is still needed on when they are offshore. Alewifes were found in salinities of 5 ppt, but are usually seen in 15-20 ppt.

- *Update on the status of creating climate projections for watersheds)*, presented by Steve Markstrom (USGS/National Research Program Central Region). USGS develops and applies physically based, watershed scale, computer models to different climate and land use scenarios in order to investigate the effect of projected climate and land use changes on watershed hydrology. Modeling of watershed hydrology includes consideration of: 1) climate change (e.g, long-term trends in precipitation, temperature, etc.); 2) land use change (e.g., urbanization: impervious area vs. depression storage); and 3) hydrologic effects (e.g., water availability). Various inputs and outputs are georeferenced in terms of locations on rivers or locations in terms of pieces of land. For example, USGS has available climate projections (e.g., Cathance Stream, ME), streamflow projections (e.g., Cathance Stream, ME), soil water projections (e.g., Cathance Stream, ME)), and stream temperature projections (e.g., Chattahooche River and Potato Creek, GA). There are different levels that need to be considered for watershed hydrological models (e.g., source of water and its residency time has large effect on the temperature of water, water quality and other factors). Additional information on the modeling of watershed systems (MOWS) can be found at http://wwwbrr.cr.usgs.gov/projects/SW_MoWS/index.html
    - Comments: USGS is trying to set up a national hydrological model and would like to run their watershed models on each USGC hydrologic response unit (HRU). At this time, there are 14 basins detailed nationwide and these will be expanded as funding allows. These would ultimately be available through web portals in the future. River temperatures are not widely derived yet for each river yet, but are on a project by project basis at this point. Soil source of water could have an affect on salinity levels in Maine. Watershed hydrology models need to consider various inputs depending on the area (e.g., stream interactions and soil moisture, surface water and ground water interactions). Steve Markstrom can provide additional information, as needed, on available models/basins, model calibration and downscale inputs used (USGS does not currently downscale). The USGS models can be done at different levels depending on the information available.

      Collaborations should be explored to determine where available watershed models overlap with available river herring data. Local USGS offices should be contacted (e.g., Maine, Connecticut) to discuss potential collaborations. One suggestion is to look at look at 4-5 watersheds on the US East coast to see if there is available data and a watershed model developed. If so, it would be an interesting study to pursue; if not, this should be identified as a need.

Additionally, if there is a watershed model without necessary river herring data, it could be used to frame the set of potential responses. Latitudinal gradients should be considered in the available watersheds models, and it would be helpful to also consider river herring data if available (e.g. obtain the kind of outputs the models are providing and consider the response with the hydrology that could be relevant to river herring). It would be important to look at a climate change projection in the watershed that has properties that are sensitive to river herring to focus research on figuring what the mechanisms are and how much do we trust the climate change projections. Mapping watershed responses and empirical relationships could define detailed mechanistic factors.

III. Key Outcomes

Below is a list of individual expert opinions provided by participants related to specific threats, data gaps, research projects, information to be considered and/or monitoring (i.e., the identified research projects and/or conservation actions). Some ideas have been combined where appropriate. These outcomes are listed in no particular order, and those related to other subgroups are also included in the "Cross-Cutting Issues" section below.

a. Data Gaps
   - Information on how climate change impacts river herring's prey (e.g., prey tolerance to salinity).
   - Acclimation timing of river herring to salinity gradients (e.g., moving into rivers and back to sea).
   - How long adults wait offshore before moving into rivers and what are the triggers (e.g., temperature).

b. Research Projects
   - River herring studies have included the marine phase (Lynch et al., 2014) and freshwater (Tomassi et al, In review), but the next step is consider the whole life cycle. The GRD3 model or similar should be considered for river herring.
   - Consider marine growth and estuarine growth in the context of environmental factors.
   - Information on how water flow and changes to it affect what river herring do (e.g., impacts on fish passage). Continue studies such as that conducted by Tomassi et al. (In review).

c. Information To Be Considered (e.g., published papers)
   - USGS watershed models.
   - Karen Wilson's compilation of temperature tolerances of river herring.
     - Table and additional information found in the NMFS River Herring Climate Change Workshop report;

http://www.nero.noaa.gov/prot_res/CandidateSpeciesProgram/sswpdocs/RIVER%20HERRING%20CLIMATE%20CHANGE%20WORKSHOP%20REPORT_122712.pdf

- Full presentation found at: http://www.nero.noaa.gov/prot_res/CandidateSpeciesProgram/ClimateChangeWorkshop/Day%201/RH%20CC%20Workshop%20KWilson.pdf

IV. Next Steps

The Climate Change Subgroup discussed the following next steps:

- Thibaud Rougier will provide the subgroup the 42 parameters he looked at for consideration. The subgroup will review these to determine what information is available, demonstrate data gaps, and help determine what is needed.
- Mike Alexander will present on a "Review and progress of climate downscaling since workshop" at the next meeting. Janet and Mike will reach-out to Nate Mantua (NOAA/NMFS/SWFSC) about presenting on "West coast salmon and climate change research" at the next meeting.
- The subgroup should receive information on any river herring projects funded through the NOAA's Climate Program Office RFP.
- Steve Markstrom can provide information on where to find the basins that USGS is currently considering and the outputs, as needed. Steve can also provide calibration references.
- The subgroup should discuss available river herring data, which USGS watershed models have been developed and which watershed models need to be developed. Additionally, framing the set of potential river herring responses in a watershed should be considered, including latitudinal gradients.
- Karen Wilson and Desiree Tomassi will communicate on what rivers in Maine may have daily river herring information, as well as USGS information.
- A draft meeting summary will be distributed to the subgroup.

V. Cross-Cutting Subgroup Issues

The following cross-cutting subgroups issues were discussed and will be further considered by the TEWG and its Ecosystem Integration Committee.

- Consider how the phenology changes with timing of the survey is important (e.g., alewives appear to be moving north, but is it because the southern fish are moving earlier?).

VI. Participants

a. Subgroup Members

The affiliation of each member can be found on the subgroup roster available at the TEWG Climate Change Subgroup website:
http://www.nero.noaa.gov/protected/riverherring/tewg/climate/index.html

Stephen McCormick
Peter Moore
Janet Nye
Charles Stock
Desiree Tomassi
Michael Alexander
Roger Rulifson
Karen Wilson
Jon Hare
Diane Borggaard

b. Public
Thibaud Rougier
Steve Markstrom
Patrick Lynch
Andrew Jones
Edith Carson

VII. Meeting Materials

The following materials were provided to support the meeting. Additional information can be found at the TEWG Climate Change Subgroup website:
http://www.nero.noaa.gov/protected/riverherring/tewg/climate/index.html

a. Draft Agenda