STAGES

VOLUME 45 (1) March 2024

INSIDE THE ISSUE

ELHS Back in the Days

10 years ago: Early Career Committee (ECC) of ELHS was established

20 years ago: Lee Fuiman took over from Perce Powles as STAGES editor and AFS recognizes the excellence of the newsletter

30 years ago: ELHS celebrates 15. year as AFS section

MESSAGE FROM THE PRESIDENT

Dear ELHS friends and colleagues:

My, oh my, I cannot wait for spring! I am suffering from the winter doldrums and yearning for my teaching to be over and both sunshine and warmth to be consistent (not just a punctuated day in the middle of what used to be a consistently cold winter)! I am jealous of those living in a sunny, warm location.

So, can you guess what I have been up to for the past couple of months? (**Hint:** look at the logo below) You guessed it, I have been planning the 47th Larval Fish Conference (LFC47), which will occur in person during **Sunday-Thursday, May 12-16, 2024** (with an optional larval fish identification workshop on Friday, May 17th).

As a reminder, the conference will occur on the southern shore of Lake Erie at Sawmill Creek Resort (Huron, OH). While abstracts are still being accepted (as I type this message), I know that dozens have been submitted of late. As a conference organizer, I have come to appreciate deadlines, as it wasn't until the first abstract deadline that abstract submissions started to flow in. I was getting nervous that I would be the first organizer to have to cancel an LFC. Thankfully, this will not be the case!

As I mentioned in my last STAGES message to you, lots will happen at the 47th LFC besides science. In addition to scientific sessions on Monday through Thursday during the daytime (May 12-16), there will be a poster session on Monday evening (May 13), an Early Career Committee event ("Tips to Avoid Scientific Burnout") on Tuesday evening, a Banquet with dinner, awards, auction, raffle, and other fun stuff on Wednesday evening, and the Larval Fish Identification Workshop all day on Friday (on South Bass Island). We also set time aside on Tuesday morning for optional excursions, where you can take a guided tour of Stone Laboratory (Ohio State University's research station on Lake Erie's Gibraltar Island) or guided combo tour of Castalia Fish Hatchery and Magee Marsh (where you can birdwatch). We also are arranging for a kayaking excursion on Tuesday morning and can help set up chart boat fishing trips, if of interest.

A full rundown of events can be found at the LFC47 website (https://larvalfishconference.com/), where you can also register. ***We encourage you to register early (by April 3rd) and book lodging (by April 12th) to save money and ensure nearby lodging at a reduced rate, respectively.***

While I cannot promise it will be sunny and warm during the conference – as Ohio's weather seems to become more unpredictable with each passing year – I can ensure you that some great science will be presented, lots of fun (and smart) people will be in attendance, and I will work hard make this a great conference.

47th Larval Fish Conference
May 12-16, 2024
Huron, Ohio
North American Great Lakes

I wish you all the best during the remainder of your winter and look forward to seeing in you in southern Ohio during mid-May. Please feel free to reach out to me if you have questions about LFC47, thoughts on how to improve the Section, or an interest in getting more involved with this Section's governance or activities.

Sincerely,

Stu Ludsin

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Registration is Open!

REGISTER HERE

Early-bird registration for the 47th Larval Fish Conference (LFC47) is now open through April 3rd.

For the best rate, register early (saves $200) and become an Early Life History Section (ELHS) member (saves $75).

- **Affiliate Members** do not belong to AFS & join the ELHS for $15. Click to join the ELHS. Affiliate members cannot vote on ELHS business.
- **Full Members** belong to AFS and pay $15 to join the ELHS. Click to join AFS. The $15 ELHS membership fee can be paid on the AFS site.

General registration begins on April 4th and will remain open until April 26th. We encourage you to take advantage of the early-bird rates and become an ELHS member to save on your registration costs.

Scientific sessions will occur during **Monday-Thursday, May 13-16, 2024**, at Sawmill Creek Resort, located in Huron, Ohio, on the southern shore of Lake Erie. Eight themes have been proposed for this year's conference.

- Temporal variability in habitat use and spatial distribution of early life stages
- Recruitment across a freshwater-to-marine continuum: seeking generality
- Life after metamorphosis: ontogeny and its impact on the ecology of juvenile pre-recruits
- Impacts of human-driven environmental change on early life stages
- How it started and how it is going: the value of long-term ichthyoplankton time-series

- Causes and consequences of variability in larval fish foraging and growth
- Aquaculture and mariculture: advancements in egg, larval, and juvenile rearing success
- Advances in systematics, early life history, and population demographics: tools of the trade

In addition to the scientific sessions, the 47th LFC will have multiple off-site excursions from which to choose (e.g., birding/fish hatchery tour, kayaking/canoeing, Stone Laboratory tour, charter fishing), an early career event (focused on preventing scientific burnout), an awards banquet with free dinner, raffle, and ELHS flag auction, and a larval fish identification workshop on Friday, May 17. Many opportunities will exist to discuss science and socialize with others interested in the early life history of freshwater and marine fishes. For more information, visit the LFC47 website or download a conference flyer here.

Lake Erie at Huron, Ohio. Courtesy of Shores & Islands Ohio.

For more information about the 47th LFC or ELHS visit:

Larval Fish Conference website: https://larvalfishconference.com/
Early Life History Section website: https://earlylifehistory.fisheries.org/
Early Life History Section on FB: https://www.facebook.com/earlylifehistory
Early Life History Section on Twitter: https://twitter.com/AFS_ELHS

For questions about LFC47, contact Stuart Ludsin (ludsin.1@osu.edu), the current president of the Early Life History Section and the primary LFC47 organizer.

EARLY CAREER COMMITTEE

Early Career Workshop: Tips to Avoid Scientific Burnout

The Early Career Committee (ECC) will host a workshop focused on *tips and tricks to avoid scientific burnout* at LFC47. The first portion of this workshop will entail a panel discussion and open question and answer session, where experienced panelists will provide their frank perspectives and recommendations for tackling this prevalent issue. This will be followed by a relaxed gathering where participants will partake in one commonly recommended tool for avoiding scientific burnout – socializing with colleagues. To enhance discussion, participants will be encouraged to read "Twelve easy steps to embrace or avoid scientific petrification" (Campana 2018) prior to attending. Though this workshop is targeted toward early career members, more senior conference participants are encouraged to join and provide any tips and tricks they have developed through their careers!

Please email afs.elhs@gmail.com if you are interested in helping with this workshop and/or joining the ECC.

NEWS FROM THE REGIONS

PACIFIC RIM REGION
AKINORI TAKASUKA

43 years after HG Moser's seminal "Morphological and Functional Aspects of Marine Fish Larvae"

Michael J. Miller

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The December 2023 issue of the Stages Newsletter introduced a list of 17 papers that will be included in a special issue of papers entitled "Early Life History and Biology of Marine Fishes: Research inspired by the work of H Geoffrey Moser", that was edited by Jeffrey M. Leis, William Watson, Bruce C. Mundy and Peter Konstantinidis. Another longer-format paper (13 figures and 5 supplementary figures) that was not able to be included in that special issue, but was peer reviewed by the special issue editors, has been published separately. This paper entitled "43 years after HG Moser's seminal "Morphological and Functional Aspects of Marine Fish Larvae: the commonalities of leptocephali and larvae of other marine teleosts", was designed to highlight some of the career achievements of HG Moser by contrasting the morphological similarities or differences between leptocephali and other types of teleost fish larvae; and by focusing on how morphology and mimicry of gelatinous zooplankton (GZ) to reduce predation has apparently been a driving force in the evolution of fish larvae. The paper illustrates that like other taxa of fish larvae, leptocephali have a variety of body shapes (Fig. 1) and pigment patterns, and both types of larvae have species with external structures such as fin extensions, external guts, or caudal filaments (Fig. 2) that appear to mimic GZ. The theme is linked to the Moser (1981) book chapter referred to in the title of the new paper, and many figures included drawings from various chapters in the huge document referred to as CalCOFI Atlas 33 (Moser, 1996), which is one of the great achievements of HG Moser, along with the "Red Book" (Moser et al., 1984) about fish larvae that was created as a tribute to his mentor and colleague E. H. Ahlstrom.

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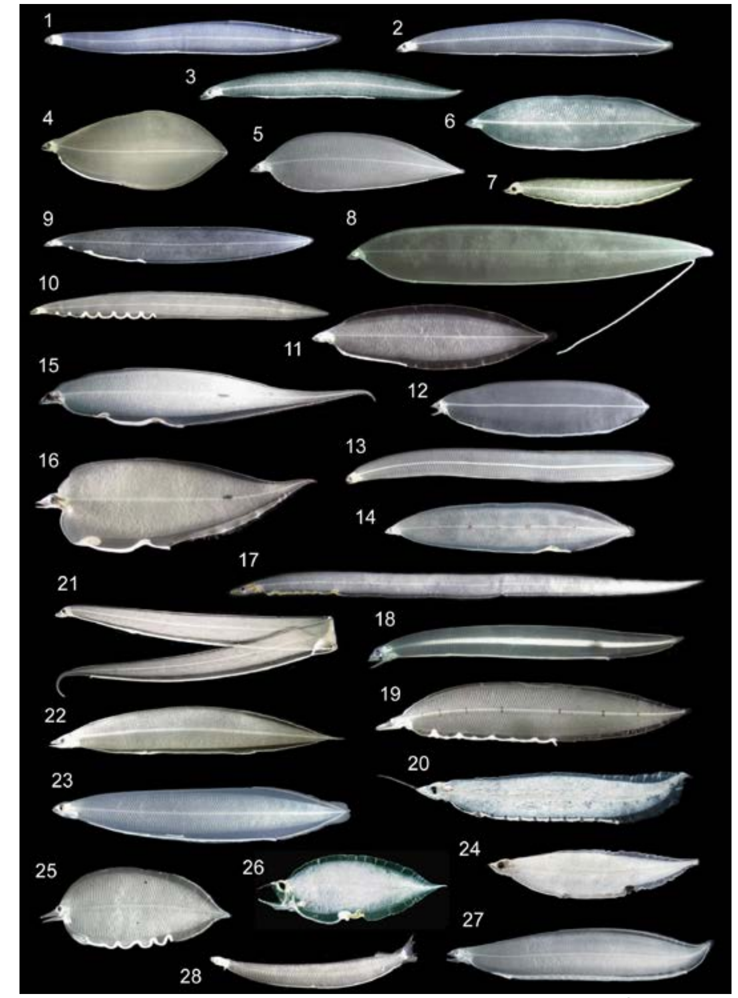

Fig. 1: Photographs of freshly caught leptocephali of the Congridae [*Conger* (1), *Gnathophis* (2), *Gorgasia* (3), *Congriscus* (4), *Gnathophis*-types (5, 6), small *Ariosoma* (7), exterilium *Ariosoma*-type (8)], Ophichthidae [*Neenchelys* (9), Myrophinae (10)], Chlopsidae (11), long and thin and deep bodied Muraenidae (12,13), Moringuidae (14], Nettastomatidae [*Nettenchelys* (15), *Nettastoma* (16), *Facciolella*-type (17)], Synaphobranchidae [Synaphobranchinae (18), Ilyophinae (19, 20)], *Nemichthys* (21), Serrivomeridae (22), *Anguilla japonica* (23), unknown Type I (24), *Cyema atrum* (25), *Eurypharynx pelecanoides* (26), Derichthyidae (*Nessorhamphus*) (27), leptocephalus of Elopidae (Elopiformes) (28). Sizes of the leptocephali are not proportional, but range in size from 19 mm in *Eurypharynx* to > 100 mm in the exterilium Ariosoma-type, the long nettastomatid and *Nemichthys*.

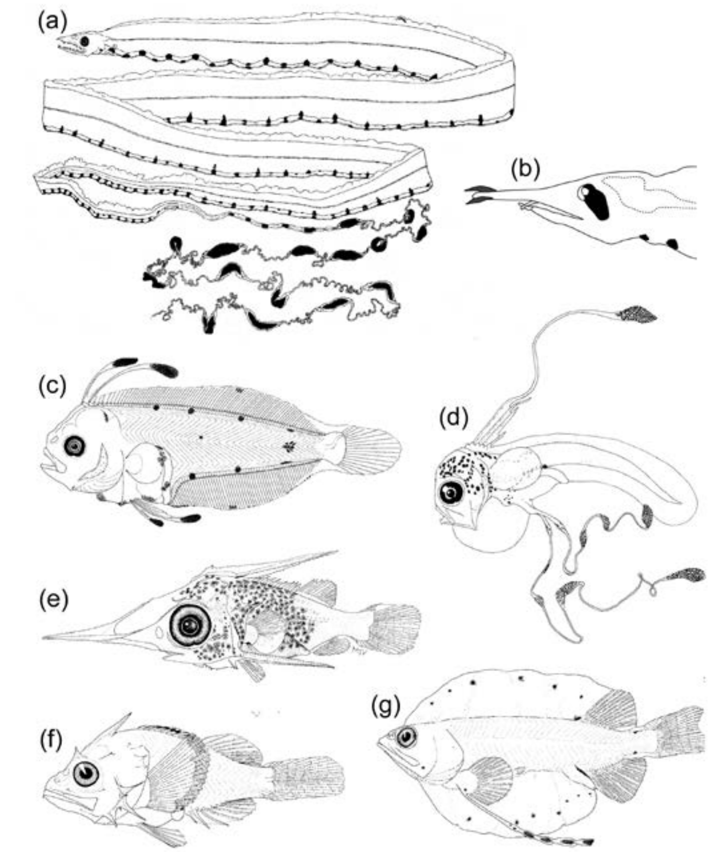

Fig. 2: Drawings of leptocephali and fish larvae (Modified from Moser, 1996) with various types of fin ray, other appendages or spines showing (a) a 314 mm notacanthid leptocephalus (Notacanthiformes) with a long caudal filament with black palps, (from Moser and Charter, 1996), (b) the head region of an unknown species of Synaphobranchidae leptocephalus (11 mm TL) with 2 black palps on a short rostral cartilage (redrawn from Miller and Tsukamoto, 2004), (c) 10.0 mm Gulf sanddab, *Citharichthys fragilis* (Paralichthyidae; Pleuronectiformes), (d) 7.4 mm King-of-the-salmon, *Trachipterus altivelis* (Trachipteridae) that was dissected from the egg, (e) 5.8 mm Tinsel squirrelfish, *Sargocentron suborbitalis* (Holocentridae; Holocentriformes), with extensive mid-body pigmentation, and large rostral, supraoccipital, and preopercular spines, (f) an 8 mm Rosy scorpionfish, *Pontinus* sp. (Scorpaenidae; Scorpaeniformes) with head spines and large pectoral fins, and (g) 17.6 mm Dwarf lanternfish, *Loweina rara* (Myctophidae; Myctophiformes).

Outcome of the visit to the Institut des Sciences de la Mer, Université du Québec à Rimouski, Canada

Shota Tanaka

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Feeding ecology is undoubtedly important for understanding the survival mechanisms of early life history of fish. Our recent study showed that growth autocorrelation during the larval stage of three clupeoid species, Japanese sardine *Sardinops melanostictus*, Japanese anchovy *Engraulis japonicus*, and Pacific round herring *Etrumeus micropus* was relatively high compared to other species studied to date (Tanaka et al., 2023). A possible mechanism driving strong growth correlation is a retroactive loop between growth performance and feeding success (Robert et al., 2014; Pepin et al., 2015). To test this "growth–feeding" relationship in clupeoid species, analysis of gut contents of larvae is essential.

In the laboratory of Dr. Dominique Robert at the Institut des Sciences de la Mer, Université du Québec à Rimouski in Canada, many studies have been conducted including the analysis of larval gut contents (e.g., Wilson et al., 2018; Burns et al., 2020, 2021) (Fig. 3). Their expertise in gut content analysis of fish larvae is well established, including methods for prey extraction, identification and measurements. To learn

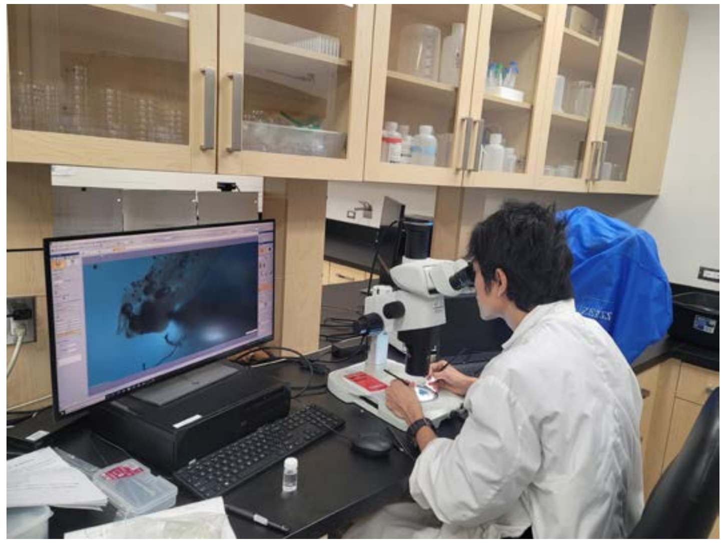

Fig. 3: Gut contents analysis using microscope-monitoring systems.

the methods, I visited and stayed in the laboratory at the end of January with the help of Dominique and his students.

The laboratory has five high-resolution microscope monitoring systems (Fig. 3). There was also a very informative booklet on how to identify zooplankton species such as copepods. I already had some knowledge of identification methods that I had learned in Japan, but I found out many identification characteristics that I did not know before and learned a lot of new things! I could immediately apply this knowledge to the gut content analysis of my own samples since my return to Japan. The "growth–feeding" relationship of clupeoid species will be studied in detail based on these techniques acquired.

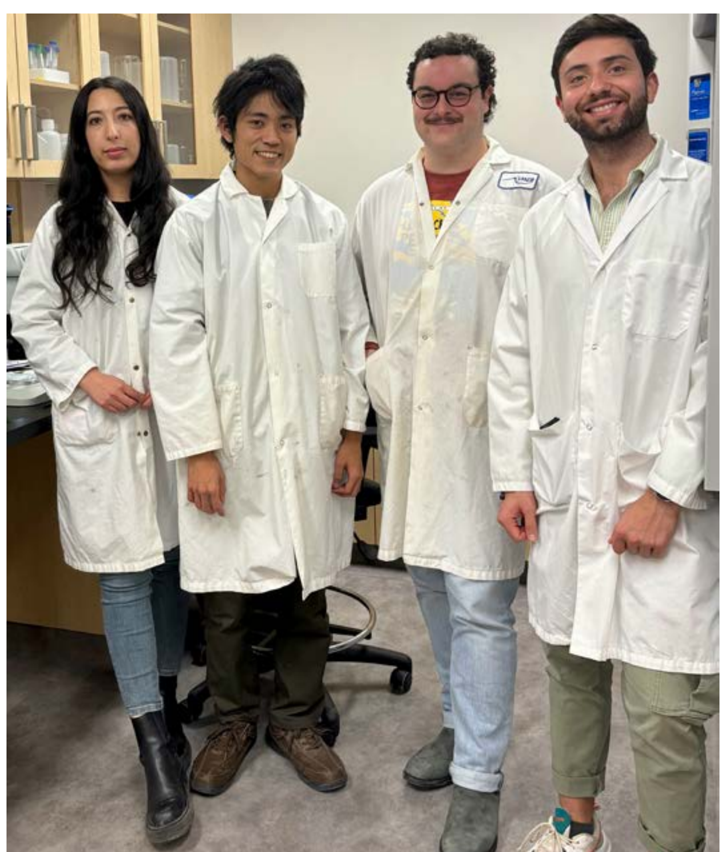

Fig. 4: From left to right: Sarra Nasraoui, Shota Tanaka, Etienne Germain, and Luis Avila.

During this stay, I mainly communicated with three members of the team: Sarra Nasraoui, Etienne Germain, and Luis Avila (Fig. 4). I was very impressed by their detailed observational skills and their attitude toward research. I was very fortunate to make great connections with people working on similar topics to my own. I look forward to meeting them again at future international conferences, including this year's 47th Annual Larval Fish Conference! This opportunity has been very useful for my future research. I would like to express my sincere thanks to Dr. Dominique Robert for this valuable opportunity.

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WESTERN REGION
DAN MARGULIES

Larval fish surveys at the National Marine Fisheries Service Pacific Islands Fisheries Science Center

Bruce C. Mundy[1], Donald Kobayashi[2], Justin Suca[2], and Ryan R. Rykaczewski[2]

[1] National Marine Fisheries Service Pacific Islands Fisheries Science Center (retired)

[2] National Marine Fisheries Service Pacific Islands Fisheries Science Center

New larval fish surveys are being conducted in the Hawaiian Archipelago to better understand the oceanographic conditions associated with the spawning and early life history (ELH) stages of fisheries management unit species (MUS), including Billfishes (Istiophoridae, Xiphiidae), Tunas (Scombridae), Snappers (Lutjanidae, Etelinae), and others. These surveys are spearheaded by the Pelagic Research Program, which is a part of NOAA Fisheries' Pacific Islands Fisheries Science Center (PIFSC).

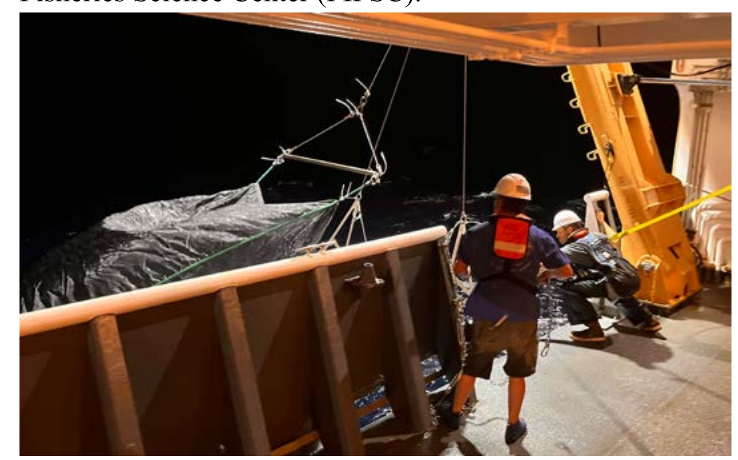

Fig. 5: Donald Kobayashi and Justin Suca collecting plankton samples with an Isaacs-Kidd midwater trawl during a Hawaiian Islands Cetacean and Ecosystem Assessment Survey (HICEAS) cruise along Kō Hawai'i Pae 'Āina (Hawaiian Archipelago).

From 2016-2018, the Hawai'i Integrated Ecosystem Assessment program, part of NOAA's national approach to Ecosystem-based Fisheries Management (EBFM), conducted neuston surveys off the west coast of Hawai'i Island to explore the ecological impact of surface slicks on coastal ecosystems. These surveys resulted in the identification of slicks, meandering lines of smooth water associated with convergences and fronts, as important nursery habitats for numerous species, including Flyingfishes (Exocoetidae), Jacks (Carangidae), Mahimahi (*Coryphaena hippurus*), Billfishes, and many reef fishes (Whitney et al., 2021). Slicks were also found to concentrate high densities of prey-sized plastics, where they pose a threat to developing larvae (Gove & Whitney et al. 2019). Accumulation of neustonic organisms and plastics were shown to vary by underlying mechanisms of slicks, with internal waves being a primary driver structuring neustonic communities in this region (Smith et al. 2022).

A sampling effort with the intention to establish a time series based on replicating work done in the 1970s by Thomas Clarke of the University of Hawai'i took place off of the west (leeward) coast of O'ahu in 2017 (Fig. 5). The aim was to assess whether changes in ichthyoplankton and zooplankton assemblage structure occurred in the 50-year interval between the two studies. Larvae from the 2017 samples are being identified (Fig. 6, 7), with data analysis pending.

Fig. 6: Scientists aboard the NOAA Ship Oscar Elton Sette do preliminary at-sea sorting of plankton samples during a Hawaiian Islands Cetacean and Ecosystem Assessment Survey (HICEAS) cruise along Kō Hawai'i Pae 'Āina (Hawaiian Archipelago).

During the COVID-19 pandemic halt of field and collaborative laboratory work, PIFSC scientists analyzed information from past collecting programs to continue their EBFM research. They published studies the spawning and ELH distribution of Green Jobfish (*Aprion virescens*), Mackerel Scad (*Decapterus macarellus*), and Bigeye Scad (*Selar crumenophthalmus*) (Schmidt et al., 2023; Contreras et al., 2023). Ichthyoplankton surveys resumed in 2022 when COVID-19 restrictions were relaxed and sampling for new projects began.

Fig. 7: Isabella Kintigh, Emily Contreras, and Andrea Schmidt in the Pacific Islands Fisheries Science Center biological laboratory sort and identify fish larvae from light trap, Isaacs-Kidd midwater trawl, and plankton net samples.

In alignment with current management interests, the surveys in 2022 focused on Bigeye Tuna (*Thunnus obesus*) larvae (Fig. 8), as well as other Tunas and Billfishes. These surveys were conducted along longitude 150°W, to the east the Hawaiian Archipelago, from 30°N to 11°N, spanning more than its latitudinal extent. Processing of these samples was recently completed and data analysis is pending. A follow-up expedition is scheduled for 2024 to further investigate spatio-temporal trends in spawning and larval habitat use of pelagic MUS.

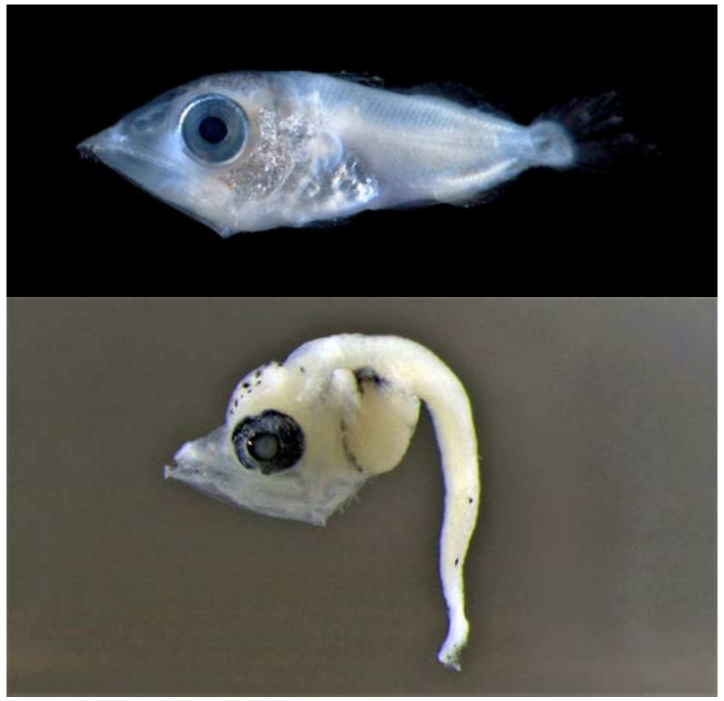

Fig 8. Bigeye Tuna larvae (*Thunnus obesus*) collected during an ichthyoplankton transect to the east of the Hawaiian Islands (freshly collected postflexion larva above, preserved preflexion larva below). The tail of the smaller specimen, with three melanophores, was twisted so that its ventral edge was toward the camera lens.

The longest sustained effort of light-trap sampling for larval fish research in the Hawaiian Archipelago ran at PIFSC during the late summer and fall of 2023. Light traps targeting nearshore fish larvae such as Snappers were deployed several nights each week for ten weeks off a leeward Oʻahu pier, providing a rich dataset to explore settlement patterns and larval assemblages in nearshore habitats.

The Pelagic Research Program's most spatially expansive ichthyoplankton sampling effort collected plankton and micronekton samples as an ancillary project during the Hawaiian Islands Cetacean and Ecosystem Assessment Survey (HICEAS). Sampling with an Isaacs-Kidd midwater trawl is done at night to avoid interrupting the daytime visual surveys for cetaceans and seabirds. This 2023 larval fish survey, with two successful cruises, was the first using modern oceanographic methods to sample the archipelago's entire length. The collections thus far produced a rich larval fish diversity that includes numerous reef-fish families and commercially important MUS such as Yellowfin Tuna (*Thunnus albacares*), Billfishes, and Snappers. The samples will serve to identify spawning regions for MUS within the Hawaiʻi EEZ and provide specimens for larval ecology studies. For some species, like Striped Marlin (*Kajikia audax*), stock assessments can be very sensitive to early life growth and spawning timing. These surveys will help us refine our understanding of those topics. The coupling of the ichthyoplankton sampling with cetacean surveys will also allow us to develop ecosystem indicators for trophic processes and water-mass properties that may relate to cetacean distribution. A noteworthy result of the 2023 HICEAS sampling was the sampling of larvae from an unusual population bloom of Buccaneer Anchovy (*Encrasicholina punctifer*), which is likely an underappreciated forage fish in the region and a potential prey item for a number of cetacean species. The collaborative cruises with the HICEAS program are planned to continue in the next few years.The samples from all of these projects are fixed and preserved in 95% ethanol for subsequent DNA analysis.

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NORTH CENTRAL REGION
STACEY IRELAND

New Technology and Advection Modeling Improves Understanding of Alewife Larvae Distribution in Southeast Lake Michigan - 2023 Field Sampling

Maddie Tomczak - University of Michigan, Cooperative Institute for Great Lakes Research (CIGLR)

Ed Rutherford - NOAA Great Lakes Environmental Research Laboratory (GLERL)

Coauthors:

NOAA GLERL: Doran Mason, Mark Rowe, Peter Alsip, Paul Glyshaw, Eliza Lugten, Steve Ruberg, Kristen Rosier

CIGLR: Heather Truong, Tait Algayer, Rao Chaganti, Lucas Vanderbilt, Russ Miller

Recruitment of fish populations is often determined by events affecting distribution, growth and survival of sensitive egg and larval stages. Statistical analysis of factors affecting first-year survival of Alewife, a key prey fish for salmon and trout in Lake Michigan, suggest warm spring-summer temperatures and low salmon predation (Madenjian et al. 2005) are possibly correlated with higher than average survival of young Alewife, but specific factors affecting distribution, survival and potential recruitment of larval Alewife are not well known. Past studies of alewife larvae in southeast Lake Michigan indicate their survival may be negatively influenced by wind-generated upwellings, leading to potential recruitment bottlenecks (Heufelder et al 1982, Höök et al 2006). The larvae are advected away from warm and productive nearshore nursery habitats to colder, less productive environments offshore, potentially lowering larval survival and growth. However, the entirety of the impact of Alewife larval dispersion from upwellings is unknown. Few studies have tracked larvae or their zooplankton prey from nearshore to offshore environments to assess their fate. We hypothesized that earlier hatching Alewife may experience lower growth and higher mortality compared to larvae hatching in July, when temperatures and zooplankton biomass are favorable and upwellings are less common.

Fig. 9: Deploying the AUV glider. photo credit Paul Glyshaw

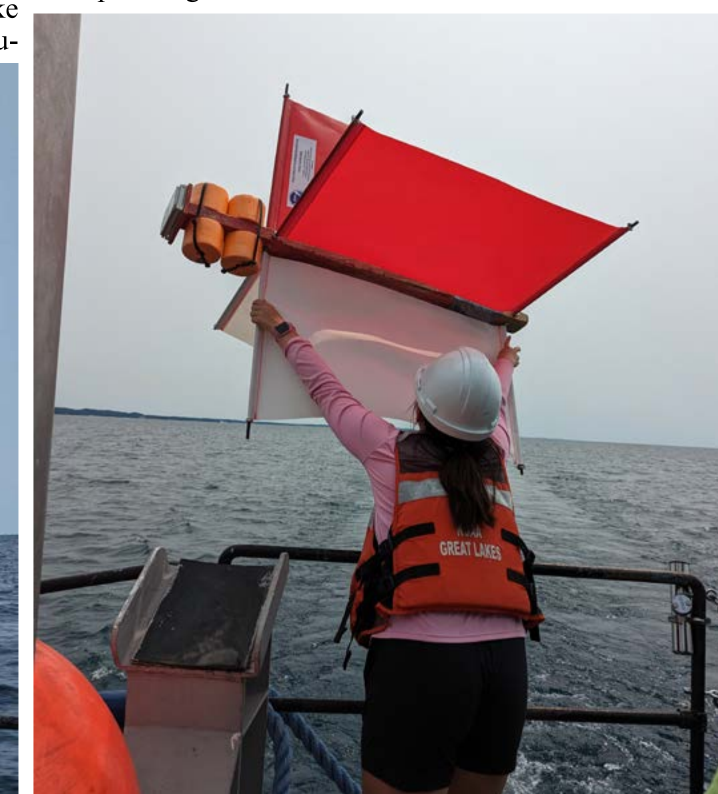

Fig. 10: Deploying tracker buoys (subsurface drifter) in Lake Michigan. photo credit Paul Glyshaw

We used hydrodynamic models, subsurface drifters, AUVs with acoustics and plankton nets to forecast, track and repeatedly sample distributions of alewife larvae, zooplankton prey, and environmental conditions before and after an upwelling event in June and July of 2023 (Figs. 9 - 11). Two CIGLR Summer Fellows students (Heather Truong, Tait Algayer) assisted with field and laboratory work. We collected water samples for eDNA and confirmed that almost all locations where we caught larvae in plankton nets also were positive for Alewife eDNA. All fish were identified and measured, and their ages, hatch dates and growth rates were estimated from otolith analysis. Preliminary results indicate there was no overlap between cohorts of larval Alewife present before and after the upwelling in June. Average individual growth rates, densities and apparent survival were higher for larvae collected in July compared to those collected in June.

Plans for 2024

In July 2024 we plan to repeat this study to track advection of larval cohorts and estimate their daily growth, mortality and distribution.

Results will be presented at the Larval Fish Conference in May, at the International Association for Great Lakes Research Conference the following week, and at National American Fisheries Society Meeting in September.

Fig. 11: AUV ready to start collecting data in Lake Michigan. photo credit Paul Glyshaw

SOUTHERN REGION
TRIKA GERARD

Larval description of the black durgon (*Melichthys niger*) in the Gulf of Mexico

Denice Drass and Glenn Zapfe

One of the tasks of utilizing a time-series like the Southeast Area Monitoring and Assessment Program (SEAMAP) to calculate larval abundance indices is examination of larval specimens to validate identifications. While this can be a tedious task when you are working with thousands of specimens collected over 40 years, it does give us the opportunity to scrutinize larval descriptions and re-evaluate developmental size series used in their creation. In our case, we examined larvae from the family Balistidae for use in a gray triggerfish (*Balistes capriscus*) stock assessment in the northern Gulf of Mexico. Six species of triggerfish (family Balistidae) have been reported in the Gulf of Mexico: gray triggerfish (*B. capriscus*), queen triggerfish (*B. vetula*), rough triggerfish (*Canthidermis maculata*), ocean triggerfish (*C. sufflamen*), black durgon (*Melichthys niger;* Fig. 12), and sargassum triggerfish (*Xanthichthys ringens*). Although the juvenile stages of all six triggerfish species occurring in the Gulf of Mexico have been described, there are only four species with published larval descriptions; *B. capriscus*, *C. maculata*, *C. sufflamen*, and *X. ringens*. During our examination of larvae from the SEAMAP collection (1982-present), we were able to gather together a sequence of larval development of *M. niger* ranging from 3.95 mm to 6.74 mm BL. Using these specimens, we were able to create a larval description that will be published in an upcoming NOAA Professional Paper NMFS Series volume dedicated to honoring Dr. Geoffrey Moser

Initial identifications of *M. niger* could be erroneously made to either *X. ringens* or *B. capriscus* based on the presence of a caudal pigment band. However, our description indicates the caudal bar in *M. niger* and *X. ringens* develops darker dorsal/ventral patches of pigment at smaller sizes than the caudal pigment development of *B. capriscus*. Separation of *M. niger* from *X. ringens* is made by the development of a diagonal internal line of pigment forming anteriorly below the third dorsal spine that extends to the middle of the soft dorsal fin. Also, the dorsal fin pigment in *M. niger* are primarily restricted to the first dorsal fin spine, leaving the dorsal fin membrane essentially unpigmented while the other two species develop pigment throughout the spinous dorsal fin membrane. For a more detailed description please look for the upcoming article.

Figs. 12: Photograph of black durgon (*Melichthys niger*, 6.74 mm SL) used to create larval description.

Although this larval description fills the gap for *M. niger*, a size-series description is still lacking for the queen triggerfish (*B. vetula*). Only one specimen of *B. vetula* has been identified in the SEAMAP collection from the Gulf of Mexico and it was a juvenile. This leaves the opportunity for mis-identification of smaller larval specimens that may have similar morphological characteristics. Our current project is to develop a size series of *B. vetula* larvae collected in the southern Gulf of Mexico and Caribbean Sea in collaboration with Dr. Estrella Malca at the NOAA Southeast Fisheries Science Center, Lourdes Vásquez Yeomans at El Colegio de la Frontera Sur (ECOSUR), and Dr. Benjamin Victor. Specimens are currently being examined that have been identified using molecular techniques to identify characteristics that can separate the larvae form the other five species found in the Gulf of Mexico.

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EUROPEAN REGION
CATRIONA CLEMMESEN

Glass eel migration in an urbanized catchment: an integral bottleneck assessment using mark-recapture

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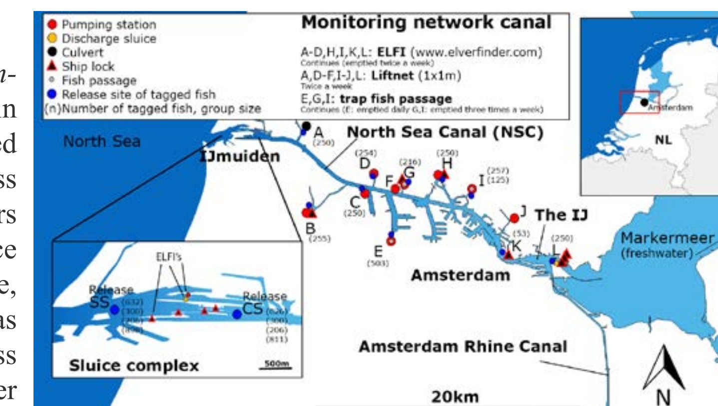
Introduction

Diadromous fish such as the European eel (*Anguilla anguilla* L.) are hampered by a high density of barriers in estuaries and freshwater systems. Modified and fragmented waterbodies lack tidal flows, and habitat may be less accessible and underutilized compared to free-flowing rivers and estuaries. With rising sea levels and increased occurrence of droughts, the number of barriers may further increase, implying that the need to study migration in such areas may even become more urgent worldwide. To study glass eel migration and behaviour in such highly modified water systems, a mark-recapture study was carried out in the North Sea Canal (NSC) basin, which drains into the North Sea via a large sluice complex (Fig. 13). To monitor and collect glass eel at the study locations, elverfinder traps ('ELFI', www.elverfinder.com) and liftnets were used. Also small, meshed traps covering the fishways were used at three locations. An ELFI is a mobile glass eel ladder that uses a continuous freshwater attraction flow pumped from the hinterland to attract and trap glass eels. Glass eels were anaesthetized with 0.4 ml/l 2-phenoxyethanol and injected in the caudal half of the body with one, two or three small Visible Implant Elastomer Tags (VIE, Northwest Marine Technology, see Fig. 14).



Figs. 13: Overview of the study site and locations. SS = IJmuiden Sea Side, CS = IJmuiden Canal Side (CS)

Figs. 14: Glass eel (*Anguilla anguilla*) with Visible Implant Elastomer Tags

Results

In total, eight uniquely tagged groups (3,797 glass eels) were released near the sluice complex, and 11 groups (2,663 glass eels) were released at inland barriers upstream over a 28 km long stretch in the NSC in spring 2018. In total, 709,098

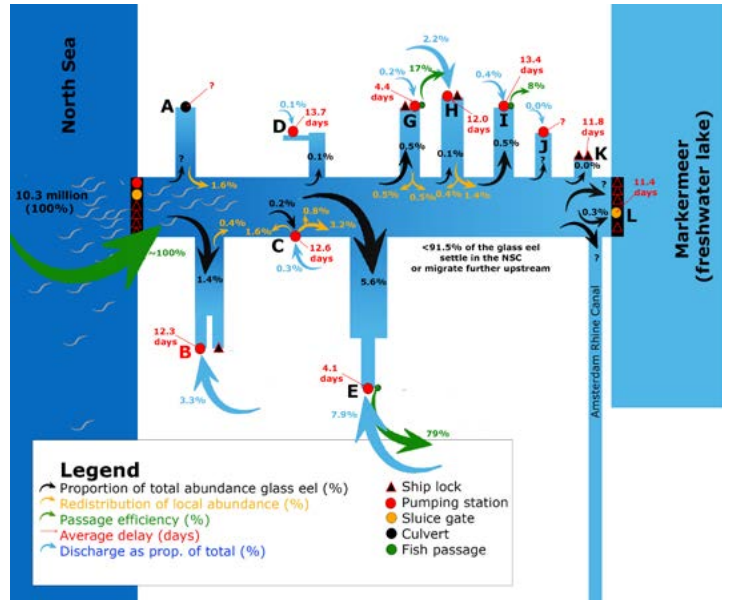


Fig. 15: Schematic integral overview of the results of the mark-recapture study in the NSC; relative freshwater discharge (blue arrows), relative glass eel distribution (black arrows) as proportion of the total abundance (10.3 million glass eel entering NSC), passage efficiency (green arrows) and redistribution between NSC outlet locations (orange arrows) are shown.

glass eels were caught and checked for VIE markings. Of the tagged glass eels released at the IJmuiden Sluice complex, either at SS or at CS, 274 glass eels (6.9%) were recaptured at different locations within the NSC. Of those, 148 glass eels (avg. 7.3%, between 5.2 and 8.5%) were from the 'SS-group' and 126 (avg. 6.5%, between 4.7 and 8.5%) were from the 'CS-group'. There was no significant difference in the recapture rate of eels released at location CS or SS ($p=0.63$) suggesting ~ 100% passage success of the sluice complex. Recaptures furthest inland were reported at location L at 26.8 and 29.4 km from the release sites CS ($n=1$) and SS ($n=5$), respectively. Abundance estimates, using the 'unbiased modified Lincoln-Peterson' method (Ricker 1975, Pollock et al 1990), showed that the sluice complex attracted 10.3 million glass eel and did not block or delay their immigration. The large and diurnally intensively used coastal ship locks and allowing some saltwater intrusion, efficiently facilitated glass eel migration.

Once in the NSC, water outlets from adjacent polders attracted glass eels relative proportional to the discharge of pumping stations. In the NSC, average migration speeds of 0.7 km/day (max. 1.8 km/day) were measured, and the average migration speed was higher in the groups released in April than in those released in March ($p<0.001$). Redistribution of glass eel from accumulations at inland barriers to other outlet locations was observed in both upstream and downstream directions in the NSC. Passage success and residence time ('delays' of 4.1–13.7 days) varied between the different inland barriers. Most of the glass eel, however, appears to settle in the easily accessible habitats within the brackish NSC catchment. The brackish highly regulated environment in the NSC appears to serve as a migration corridor and be suitable for the settlement of glass eel in a similar way as natural estuaries.

The local abundance of all outlet locations along the NSC combined as proportion to the total abundance explained only 8.5% of the glass eels entering the NSC, suggesting that the majority settled in the NSC itself or in the connected and thus easily accessible habitats of the Amsterdam Rhine Canal, smaller canals of Amsterdam and/or migrated further upstream (Fig. 15 for an overview of the results).

Conclusion

This study demonstrates an integral approach to quantify glass eel migration in a highly regulated and modified inland water system. This result showed that a large sluice complex at the mouth of the NSC did not act as a coastal barrier for glass eel passage, but subsequent inland barriers did hamper further upstream passage. With climate change and increasing water levels, coastal water systems will be even more regulated and will affect glass eel migration. The discharge through the sluice complex at IJmuiden attracted large numbers of glass eel (10.3 million). The large and diurnally intensively used ship locks, created noticeable salinity gradients and facilitated unhampered immigration of glass eel with ~ 100% efficiency and no detectable delays. Gaining more insight into the factors that determined this successful passage may aid in finding solutions at other coastal barriers. Subsequent inland barriers, however, severely hampered further migration, which resulted in large areas of potential habitat being underutilized and inducing prolonged accumulations of glass eel with unknown consequences. In modified areas where tidal currents are lacking, glass eels use active swimming (instead of selective tidal stream transport) and show redistribution in all directions to settle in the hinterland or to migrate further inland. Glass eels were attracted by freshwater flows derived from pumping stations.

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LARVA OF THE ISSUE

Coho (*Oncorhynchus kisutch*) are reared at the US Fish and Wildlife Service's Abernathy Fish Technology Center to support applied research regarding nutrition and act as hosts for studies on native Western Pearlshell Mussels that require a salmonid host in their larval phase. Coho are being reared by Dr. Ann Gannam, Dr. Neil Ashton, Kathryn Medina, and Amanda Sheehy. Photos taken by AL Deary.

Fig. 17: A coho fry that is approximately 1 month old and 4.9 cm fork length (FL).

Fig. 18: As opposed to the previously pictured handsome fry individual, this coho larva is smaller in length at 3.5 cm FL and noticeably less girthy despite being the same age.

RAMBLE ON

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