



Newsletter of the  
**Early Life History Section**  
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## Student Award Winners

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## ELHS Back Then

**2016:** 40th LFC is held in honour of Edward D. Houde's retirement.

**5 years ago:** The 2010 Elbert H. Ahlstrom Lifetime Achievement Award was presented to Edward Houde at the 35th LFC in Wilmington NC May 2011.

**12 years ago:** First of the VIMS Larval Fish courses taught by Edward Houde and others and which many of the ELHS members have taken since.

**19 years ago:** Edward Houde receives the Beverton Award from the Fisheries Society of the British Isles.

**33 years ago:** Edward Houde becomes Director of the National Science Foundation's Biological Oceanography Program.

The winner of the Sally L. Richardson Award for best oral presentation at the LFC was Igal Berenshtein (left), from Department of Life Sciences, Eilat Campus, Ben-Gurion University, Be'er Sheva and Interuniversity Institute for Marine Sciences, Eilat, Israel for his presentation "*Directional swimming in coral reef fish larvae.*"

The winner of the John H. S. Blaxter Award was Cathrine Boerseth from the Oceanographic Institute, University of São Paulo, Brazil for her poster "*Spatial dynamics and characterization of the ichthyoplankton community of natural and artificial reef environments on the Paran coast, south Brazil.*" Congratulations to these talented young scientists! §



## President's Message



Dear colleagues,

I'm writing today from south Mississippi, where the heat index is a balmy 98° F -- my calendar says the first day of Fall was a week ago, but I have to disagree (with all due respect to the autumn equinox). So, I escape to the coffee shop for a frozen caffeinated drink and to write this message, as a welcomed respite from the September heat.

In the last issue of STAGES, outgoing President Myron Peck dedicated a portion of his farewell address to the spirit of volunteerism, and the importance of an active membership. I'd like to continue to beat that drum in the opening of this message. The success of any organization depends on its members, and we are fortunate to have many members willing to serve the section. At the 2016 Larval Fish Conference, we welcomed Ed Roseman and Katey Marancik as our new North Central and North East Regional Representatives, respectively. We also put out a call for candidates willing to run for our remaining vacant positions, and the response has been great. I'm happy to report that we will have several candidates for Southern Regional Representative and Secretary-Elect. Thanks to all of you!

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**Deadline for material  
to be included in the  
next issue of Stages:**

**January 13, 2017**

## News from the Regions



### Pacific Rim Region

Akinori Takasuka

*Introducing “ECOLATUN”: a new project has started for comparative ecology of Atlantic bluefin tuna larvae between Mediterranean and Gulf of Mexico*

Recently, I was invited to participate in the kick-off meeting of the research project “Comparative trophic ECOlogy of Larvae of Atlantic Bluefin

TUNa (*Thunnus thynnus*) from NW Mediterranean and Gulf of Mexico spawning areas (ECOLATUN)” funded by Spanish Government (CTM2015-68473-R (MINECO/FEDER) was held at Centro Oceanográfico de Málaga, Instituto Español de Oceanografía (IEO) in Fuengirola (Málaga), Spain, during September 8–9, 2016. The meeting was well organized by Dr.

Raúl Laiz Carrión, PI of the project in collaboration with Alberto García García (IEO). The project is multidisciplinary in which the IEO Larval Ecology Research Group is integrated with scientists of the Balearic Islands IEO laboratory and SOCIB led by Dr. Francisco Alemany and partners from US (NOAA, WHOI and CUNY) and Mexico (ECOSUR). Such a collaboration offers the benefits of using comparative approaches to



*Discussion scene.*

deepening understanding of the larval ecology of tuna species between the NW Mediterranean and the Gulf of Mexico. Although my target species are small pelagic fish, the meeting was full of interesting topics of early life biology. The project has started on a well-established networking environment for multidisciplinary and intersystem collaborations.

On the first day of the meeting, the participants shared the project overview and discussed the motivation, objectives, survey plans, sampling methods, and analysis for multiple topics on bluefin tuna larvae (e.g. population genetics, assemblages, growth, trophodynamics, and relevant oceanography). On the second day, several topics of early life biology

*...continued on p. 4*



*Group photo at Centro Oceanográfico de Málaga, Instituto Español de Oceanografía (IEO) in Fuengirola (Málaga).*

## Section Officers

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**HELP KEEP  
STAGES INTERESTING...**

*Send us a report of your  
research activities.*





## Western region

Dan Margulies

### Larval Fish Laboratory Publishes Guide to Cyprinid Larvae

Snyder, D. E., S. C. Seal, J. A. Charles, and C. L. Bjork. 2016. *Cyprinid fish larvae and early juveniles of the Upper Colorado River Basin: Morphological descriptions, Comparisons, and Computer Interactive Key*. Colorado Parks and Wildlife Technical Publication 47.

During the past decade, 68 species of fish have been found in the Upper Colorado River Basin (UCRB). Although they represent 14 families, over a third of the fish belong to just one family, Cyprinidae. Of all the fish, only 13 species (4 families) are native, and nearly a third of these are federally endangered and subject to recovery efforts by the Upper Colorado River Endangered Fish Recovery Program—one catostomid, Razorback Sucker *Xyrauchen texanus*, and three cyprinids, Humpback Chub *Gila cypha*, Bonytail *G. elegans*, and Colorado Pikeminnow *Ptychocheilus lucius*.

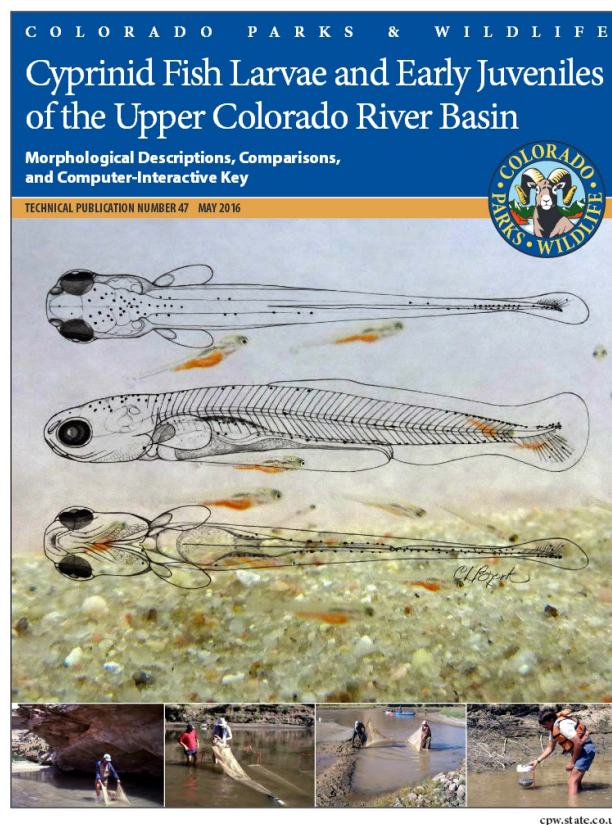
Collections of the early life stages of fish are essential for researching and monitoring fish spawning sites and seasons, production, transport, distribution, nursery habitat, survival, and other aspects of early life history. Such investigations require accurate identification of at least the target species among collected specimens. However, the larvae of most fishes change dramatically as they grow and develop, which can make diagnosis especially difficult and complicated (e.g., the 60-page key for larvae of just six UCRB catostomids in Snyder and Muth 1990).

Colorado State University Larval Fish Laboratory (LFL) objectives for this guide were to better describe and facilitate identification of the larvae and early juveniles of 15 cyprinids

in the UCRB. These included the three endangered cyprinids, two remaining native cyprinids (Roundtail Chub *G. robusta* and Speckled Dace *Rhinichthys osculus*), and ten non-native cyprinids (Red Shiner *Cyprinella lutrensis*, Common Carp *Cyprinus carpio*, Utah Chub *Gila atraria*, Brassy Minnow *Hybognathus hankinsoni*, Golden Shiner *Notemigonus crysoleucas*, Sand Shiner *Notropis stramineus*, Fathead Minnow *Pimephales promelas*, Longnose Dace *Rhinichthys cataractae*, Redside Shiner *Richardsonius balteatus*, and Creek Chub *Semotilus atromaculatus*). Nine other non-native cyprinids in the UCRB were either not recognized as present when the guide was planned or considered unlikely to be encountered as larvae in Recovery Program investigations. However, larval descriptions were referenced for all but two of these which remain undescribed.

The guide was built upon a foundation of information, species accounts, and keys previously assembled for Snyder (1981), Muth (1990), and Snyder *et al.* (2005). In doing so, we studied developmental series of reared and collected specimens to more completely document differences in size relative to developmental state, morphology, meristics, and pigmentation. Newly acquired or re-examined data were summarized for over 1,700 specimens. Also, 66 new three-view drawings were prepared to complete sets of 8 illustrations per species which document typical body form and pigmentation from recently hatched larvae through early juveniles. The results are presented in detailed descriptive species accounts, comparative summary tables, and an associated computer-interactive key.

For complex data sets (e.g., those covering the early developmental stages of various taxa), computer-interactive keys are much more user friendly and flexible than printed dichotomous or polychotomous keys. They are also much easier to prepare, correct, and update. In addition to the key for cyprinid larvae and juveniles, a second associated computer-interactive key (Snyder and Seal 2008) is provided for identification of all larvae and juveniles at the family level. Also, to complement the subset of families specifically defined for the UCRB in that key, applicable portions of a pictorial guide to families by Wallus *et al.* (1990)



were modified as an appendix to the publication.

Work on the guide was funded primarily by the Recovery Program through the U.S. Bureau of Reclamation and co-sponsored by the Glen Canyon National Recreation Area through the National Park Service Colorado Plateau Cooperative Ecosystem Studies Unit. Four shared species accounts and completion of associated portions of the guide and key were also partially

...continued on p. 6



## North East Region

Katey Marancik

### *Atlantic silversides in the spotlight: how will climate change affect these important forage fish?*

Since December 2015, Drs. Hannes Baumann (University of Connecticut) and Janet Nye (Stony Brook University) have been working on an NSF-funded project to assess the combined effects of temperature, acidification and hypoxia on the survival, growth, fecundity, sex ratio and physiology of the Atlantic silverside, a widely distributed forage fish along the US east coast. In spring 2016 they, along with graduate students Chris Murray, Jake Snyder, Adelle Molina and Teresa Schwemmer conducted the first set of factorial multi-stressor experiments.

One aspect of the project is to determine the physiological mechanisms that modulate the

sensitivity of the early life stages to acidification and warming using microrespirometry and other techniques. Experiments next year will test the separate and combined effects of static vs. diel fluctuations in pCO<sub>2</sub> and DO on multiple endpoints during the embryonic, larval, and juvenile stages in silversides. A first manuscript on the findings of CO<sub>2</sub>-induced shifts in distributions of silverside length, weight, and condition factor has just been accepted for publication in the ICES Journal of Marine Science.



Murray, C. S., Fuiman, L., and Baumann, H. Consequences of elevated CO<sub>2</sub> exposure across multiple life stages in a coastal forage fish. ICES Journal of Marine Science (in press).

--Hannes Baumann and Janet Nye §

### *Atlantic Bluefin Tuna spawning in the Slope Sea*

This past spring a paper was published in the Proceedings of the National Academy of Sciences (Richardson et al. 2016) documenting an additional spawning ground for Atlantic bluefin tuna in an area known as the Slope Sea, between the northeast United States continental shelf and the Gulf Stream. Prior to this discovery, the Gulf of Mexico and Mediterranean Sea were considered to be the near exclusive spawning grounds of Atlantic bluefin tuna.

The supporting evidence for the discovery of this spawning ground came from two opportunistic cruises into the Slope Sea by the Northeast Fisheries Science Center during the summer of 2013. On these two cruises 67 bluefin

...continued on p. 8

### *Pacific Rim Region ...cont'd from p. 2*

and current modelling approaches were also introduced toward wrap-up discussion on future activities. Further, the participants prepared materials for an ICCAT GBYP workshop on "Bluefin tuna larval studies and surveys" held in Madrid, 12-14 September 2016. The ICCAT workshop was intended to plan surveys and studies to develop a larval

abundance index as a tool for stock assessment of Bluefin tuna. The ECOLATUN project participants agreed to emphasize the importance of larval ecology in studies on larval index.

The ECOLATUN project is expected to lead to substantial advances in understanding of recruitment mechanisms of bluefin tuna, and contribute to understanding early life biology of fish in general. For details of the project (members, surveys, publications, etc.), please check the ECOLATUN website. The project can be found also on Facebook and Twitter:



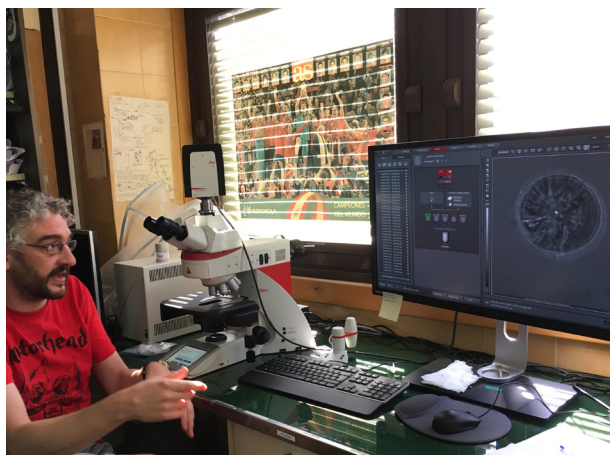
Group photo at ICCAT office in Madrid.

ECOLATUN website: <http://raullaiz.wixsite.com/ecolatun>

Facebook: <https://www.facebook.com/ecolatun>

Twitter: <https://twitter.com/ecolatun>

--Akinori Takasuka §



Otolith image analysis system used in the project.





## North Central Region

Ed Roseman

### *News from the U.S. Geological Survey Great Lakes Science Center in Ann Arbor, MI*

Scientists at the US Geological Survey Great Lakes Science Center in Ann Arbor, MI continue to design, construct, and assess artificial spawning reefs constructed in the St. Clair and Detroit rivers. The objective of these projects is to repatriate lithophilic spawning habitat that was lost due to construction of shipping channels and other anthropogenic consequences over the past 150 years. To date, over 12 acres (~5 Ha) of rock reef habitat have been created. Intensive post construction assessment of fish use of these reefs has shown that several native fish species actively spawned on the reefs, including the lake sturgeon (*Acipenser fulvescens*). Spawning reef construction will continue in the Detroit River in late 2016 and 2017 with intentions to add approximately 6 more acres of spawning habitat in the upper segment of the river near Belle Isle. Descriptions of the team's assessment approach and application of their

sampling results are documented in several publications:

Vaccaro, L., Bennion, D., Boase, J., Bohling, M., Chiotti, J., Craig, J., Drouin, R., Fischer, J., Kennedy, G., Manny, B., Read, J., Roseman E. and Thomas, M. 2016. Science in Action: Lessons Learned from Fish Spawning Habitat Restoration in the St. Clair and Detroit Rivers. [MICHU-16-501] Ann Arbor, MI: University of Michigan.

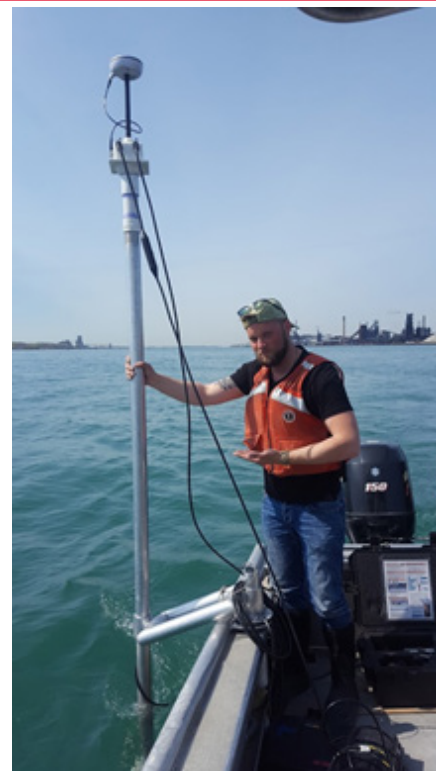
Fischer, J., Bennion, D., Roseman, E. F. and Manny, B. A. In press. Validation of a spatial model used to locate fish spawning reef construction sites in the St. Clair-Detroit River System. *Journal of Great Lakes Research*. doi:10.1016/j.jglr.2015.09.019.

Brodnik R. M., Fraker, M. E., Anderson, E. J., Carreon-Martinez, L., DeVanna, K. M., Heath, D.D., Reichert, J. M., Roseman, E.F. and Ludsin, S. A. 2015. Complementing molecular analyses of subpopulation structure with information on larval dispersal trajectories alters connectivity estimates in a Great Lakes yellow perch (*Perca flavescens*) population. *Canadian Journal of Fisheries and Aquatic Research*, 73(3): 416-426; doi: 10.1139/cjfas-2015-0161.

Fraker, M. E., Anderson, E. J., May, C. J., Chen, K.-Y., Davis, J. J., DeVanna, K. M., DuFour, M. R., Marschall, E. A., Mayer, C. M., Miner, J. G., Pangle, K. L., Pritt, J. J., Roseman, E. F., Tyson, J. T., Zhao, Y. and Ludsin, S. A. 2015. Stock-specific advection of larval walleye (*Sander vitreus*) in western Lake Erie: Implications for larval growth, mixing, and stock discrimination. *Journal of Great Lakes Research* 41(3): 830-845.

McCullough, D., Roseman, E. F., Keeler, K. M., DeBruyne, R. L., Pritt, J. J., Thompson, P. A., Ireland, S., Ross, J., Bowser, D., Hunter, R. D., Castle, D., Fischer, J. and Provo, S. 2015. Abundance, Distribution, and Diet of Transient Larval Burbot in the St. Clair-Detroit Rivers System. *Hydrobiologia* 757(1): 21-34.

Pritt, J., E.F. Roseman, J.E. Ross, and R.L. DeBruyne. 2015. Using larval fish community structure to guide long-term monitoring of fish spawning activity. *North American Journal of*



*Technician Nathan Williams setting up the acoustic Doppler current profiler to measure flows over an artificial reef in the Detroit River.*

*Fisheries Management* 35 (2), 241-252.

Marranca, J.M., A. Welsh, and E.F. Roseman. 2015. Genetic effects of habitat restoration in the Laurentian Great Lakes: an assessment of lake sturgeon origin and genetic diversity. *Restoration Ecology* 23(4): 455-464.

McLean, M.W., E.F. Roseman, J. Pritt, B.A. Manny, G. Kennedy. 2014. Overview of artificial reefs in the Laurentian Great Lakes. *Journal of Great Lakes Research* 41: 1-8. doi:10.1016/j.jglr.2014.11.021.

Manny, B.A., E.F. Roseman, G. Kennedy, J.C. Boase, J.M. Craig, D.H. Bennion, J. Read, L. Vacarro, J. Chiotti, and R. Drouin. 2015. A scientific basis for restoring fish spawning habitat in the St. Clair and Detroit rivers of the Laurentian Great Lakes. *Restoration Ecology* 23(2): 149-156.

§

### *Renovation of the GLSC's wet laboratory*

Other exciting news here in Ann Arbor is the renovation of the GLSC's wet lab. Quoting from the web site (<http://>

...continued on p. 6



*Examining egg mats for evidence of spawning on artificial reefs in the Detroit River.*

*North Central Region...cont'd from p. 5*  
[www.glsc.usgs.gov/features#147409](http://www.glsc.usgs.gov/features#147409):  
 "The GLSC's aquatic research lab in Ann Arbor was key to many science milestones in the second half of the 20th century. However, by the late 1990s, the lab had been used beyond repair. To ensure GLSC scientists continue to provide critical scientific information to state, provincial, and

tribal environmental managers in the 21st century, the GSLC has built a new aquatic lab in Ann Arbor. The new lab holds 30,000 gallons of water and covers 6,000 square feet. There are 128 tanks, ranging in size from 10 gallons to 1000 gallons, which allow scientists to hold all but the largest size Great Lakes fish. The lab also offers 64 vertical Heath trays for incubating

salmonid eggs, and 72 McDonald jars for incubating eggs of other species. Water temperature, oxygen, pH, and flow can be controlled in all of the tanks, with water turnover (complete replacement) times as fast as one hour."

--Ed Roseman §

*Western Region...cont'd from p. 3*  
 funded as part of a similar project for cypriniform larvae of the Middle Rio Grande by the Middle Rio Grande Endangered Species Act Collaborative Program, also through the U.S. Bureau of Reclamation. The guide was peer-reviewed as a final report of the Recovery Program and published by Colorado Parks and Wildlife in their Technical Publication series. Together with a similar, previously published guide for catostomids (Snyder and Muth 2004), it completes a series of descriptive investigations on the larvae of cypriniform fishes in the UCRB that LFL began over 35 years ago.

be downloaded also from the above referenced LFL web page. Check the website periodically for possible future updates of the key data sets. The current compressed folder of files for the UCRB cyprinid key (Cyp-ucrb-r.zip) includes an updated data set that replaces an earlier 2015 version (Cyp-ucrb.zip). If you had already installed the host program and original version of the key data set (Cyp-ucrb folder) on your computer in 2015, just download and uncompress (unzip) the revised data set and substitute that folder (Cyp-ucrb-r) for the original data set (Cyp-ucrb) folder in your DELTA program folder.

juveniles of the Upper Colorado River Basin—morphological descriptions, comparisons, and computer-interactive key. Colorado Division of Wildlife Technical Publication 42.

Snyder, D. E., and Seal, S.C. 2008 onwards. Computer-interactive key to families of larval fishes in freshwaters of the United States and Canada (data set for use with DELTA Intkey). Larval Fish Laboratory, Colorado State University, Fort Collins. Available: <http://warnercnr.colostate.edu/lfl-downloadable-keys-guides-and-bibliography>.

Snyder, D. E., and Seal, S.C. 2015 onwards. Computer-interactive key to eggs, larvae, and early juveniles of cyprinid fishes in the Upper Colorado River Basin (data set for use with DELTA Intkey). Larval Fish Laboratory, Colorado State University, Fort Collins. Available: <http://warnercnr.colostate.edu/lfl-downloadable-keys-guides-and-bibliography>.

Snyder, D. E., Bestgen, K. R. and Seal, S. C. 2005. Native cypriniform fish larvae of the Gila River Basin—morphological descriptions, comparisons, and computer-interactive keys. Final report of Colorado State University Larval Fish Laboratory to U.S. Bureau of Reclamation, Phoenix, Arizona.

Wallus, R., Simon, T. P. and Yeager, B. L. 1990. Reproductive biology and early life history of fishes in the Ohio River drainage, volume 1: Acipenseridae through Esocidae. Tennessee Valley Authority, Chattanooga.

--Darrel E. Snyder, Larval Fish Laboratory, Colorado State University, Fort Collins, CO 80523 ([darrel.snyder@colostate.edu](mailto:darrel.snyder@colostate.edu)) §

### Availability

Printed versions of the guide, which include a CD (on the inside back cover) with a digital (PDF) version of the guide and files for the associated cyprinid and family-level computer-interactive keys, are available upon request from Colorado Parks and Wildlife (CPW Research Center Library, 317 W. Prospect St., Fort Collins, CO 80526; e-mail: [kay.knudsen@state.co.us](mailto:kay.knudsen@state.co.us); phone: 970-472-4353). Digital (PDF) copies of the publication are available on the CPW and LFL websites, respectively at <http://cpw.state.co.us/learn/Pages/ResearchAquaticPublications.aspx> and <http://warnercnr.colostate.edu/lfl-downloadable-keys-guides-and-bibliography>.

The associated computer-interactive keys (Snyder and Seal 2008 onwards, 2015 onwards) can be run directly from the CD or installed with the host program, DELTA IntKey (<http://delta-intkey.com/>; Dallwitz *et al.* 1995 onwards), on your computer. Instructions for installation and use are provided in the guide and a "readme" file on the CD. For persons downloading PDF copies of the guide, the data sets for the keys can

### Literature Cited

Dallwitz, M. J., T. A. Paine, and E. J. Zurcher. 1995 (onwards). User's guide to Intkey: a program for interactive identification and information retrieval, 1st edition. Commonwealth Scientific and Industrial Research Organization Department of Entomology, Canberra, Australia. Available: <http://delta.intkey.com/>, under "Programs and documentation".

Muth, R. T. 1990. Ontogeny and taxonomy of Humpback Chub, Bonytail, and Roundtail Chub larvae and early juveniles. Doctoral dissertation. Colorado State University, Fort Collins.

Snyder, D. E. 1981. Contributions to a guide to the cypriniform fish larvae of the Upper Colorado River System in Colorado. U.S. Bureau of Land Management Biological Sciences Series 3, Denver, CO.

Snyder, D. E., and Muth, R.T. 1990. Description and identification of Razorback, Flannelmouth, White, Utah, Bluehead, and Mountain Sucker larvae and early juveniles. Colorado Division of Wildlife Technical Publication 38.

Snyder, D. E., and Muth, R. T. 2004. Catostomid fish larvae and early



## Southern Region

### *Investigating effects of commercial feed provision on early-life diets and digestive ontogeny of Channel, Blue, and Channel × Blue hybrid catfish*

Channel Catfish (*Ictalurus punctatus*) production has led the United States aquaculture industry by market yield and value since about 1970. The catfish industry rapidly grew and intensified from the 1970s through the 1990s, followed by general decline

(hereafter, hybrid catfish) to stock in grow-out ponds, hatchery managers must develop appropriate feeding methods for fry of both parent species and the hybrids.

My current research aims to improve catfish production reliability by understanding the effects of commercial feed provision on diets and growth of Channel, Blue, and hybrid catfish during the transition from yolk-sac to exogenous feeding. Hatchery managers typically maintain all catfish fry on commercial feed in flow-through tanks for the first two weeks of life, after which they are stocked in fertilized nursery ponds. Commercial feeds are also added to ponds daily after fry stocking. However, recent studies found that Channel Catfish growth is wholly sustained by zooplankton and insects during the early weeks in ponds. The voluntary diet switch of Channel Catfish fry from commercial feed in hatchery tanks to live prey in ponds suggests zooplankton and insects may constitute the preferred diets of first-feeding catfish.

Moreover, restricting catfish to an inert commercial feed during first-feeding may delay, enhance, or alter digestive enzyme expression and thereby influence growth and survival.

During May and June 2016, I conducted two experiments at Southern Arkansas University (SAU) to test the effects of commercial feed provision on diet composition, digestive

enzyme activities, and growth of Channel, Blue, and hybrid catfish during early life. I conducted both experiments in 75L glass aquaria that I filled with pond water and stocked with high densities of crustacean zooplankton harvested using a canister filter attached to a submersible pump. I conducted Experiment 1

using a 2×2 factorial design by stocking Channel or hybrid catfish in tanks and providing the fish access to zooplankton only or zooplankton plus a commercial feed. I conducted Experiment 2 by providing Channel, Blue, or hybrid catfish access to zooplankton plus a commercial feed. All yolk-sac fry and the commercial feed were provided by my collaborator, Nagaraj Chatakondi, at the Thad Cochran National Warmwater Aquaculture Center in Stoneville, Mississippi. Nagaraj also provided valuable advice in design and conduct of the experiments.

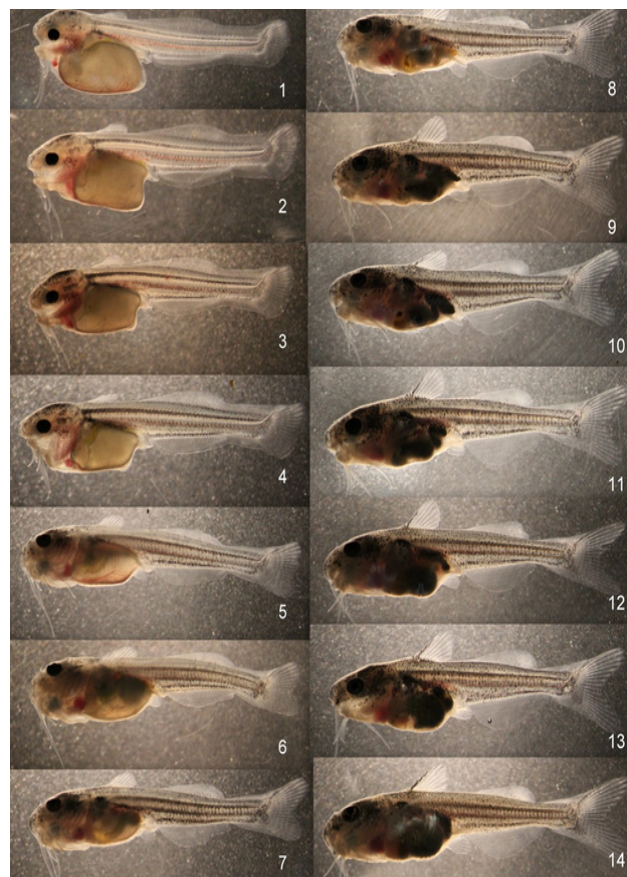
In both experiments, I sampled fish at noon and midnight every 3 days from age 4 to 13 days. I will examine gut contents of the fish relative to their environmental prey fields to quantify preferences for zooplankton. Zooplankton samples are currently being enumerated by my collaborator at Ohio State University, Cathy Doyle. I will also work with undergraduate students at SAU to measure digestive

*...continued on p. 8*



*Hybrid catfish fry (7 days old, 15mm total length) photographed in a glass aquarium during Experiment 2.*

in the 2000s. In recent years, the downsized catfish industry began a shift from production of Channel Catfish to hybrid catfish (Channel Catfish ♀ × Blue Catfish ♂ *I. furcatus*) to improve production efficiency and profitability. F1 hybrids produced from a female Channel Catfish have superior production characteristics as compared to both parent species, the reciprocal F1 cross, and subsequent hybrid generations. To maintain a reliable supply of F1 hybrid catfish



*Development of hybrid catfish during the first two weeks of life, with age in days denoted on each image. Photographs were taken under a stereomicroscope and are not shown to scale. Note the first appearance of food in the gut occurred in fish 5–7 days old.*

*North East Region ...cont'd from p. 4*

tuna larvae were collected, many at very early stages of development. One of the major challenges overcome during this study was that most of the samples were preserved in formalin, which severely compromises the ability to implement genetic identification techniques. Scientists at the Alaska Fisheries Science Center were able to develop a technique to sequence short fragments of the highly variable NADH dehydrogenase 5 gene to confirm that these larvae were in fact bluefin tuna. An evaluation of larval transport rates using data from oceanographic drifters, and the temperature and salinity properties of the collection locations, confirmed that these larvae did not originate in the known Gulf of Mexico spawning grounds. Rather the larvae were locally produced during a spawning season that is about two months later than the Gulf of Mexico spawning season.

This discovery added strong support to a hypothesis, first proposed over 40 years ago, that Atlantic bluefin tuna in the western Atlantic exhibit size-structured spawning grounds. In the late 1950s and early 1960s the Bureau of Commercial Fisheries, the predecessor to the National Marine Fisheries Service, sponsored exploratory longline cruises, including some into the Slope Sea, to evaluate the tuna resources off of the United States. One of these cruises during the summer of 1957 collected tuna in spawning condition, including one documented as "running ripe" (Baglin

1976). During that cruise medium sized bluefin tuna (130-220 cm FL) were in spawning condition whereas larger tuna were largely spent. In contrast the Gulf of Mexico spawning ground is nearly exclusively occupied by the largest bluefin tuna. An analysis of electronic tagging data confirmed that Atlantic bluefin tuna exhibit a differential migration pattern. Larger fish enter the Gulf of Mexico spawning ground but then move rapidly through the Slope Sea on their migration to northern feeding areas, whereas medium size fish enter the Slope Sea during the spawning season where they remain resident for a more extended period of time.

During the summer of 2016 plankton sampling occurred in the Slope Sea to further evaluate this spawning ground and to collect biological material for additional studies. Targeted sampling at 24 stations occurred during a three day transit of the NOAA ship Gordon Gunter from Rhode Island to Norfolk, Virginia. Additionally, opportunistic sampling occurred on a marine mammal survey aboard the NOAA ship Henry Bigelow. Processing of the plankton samples



*3.5mm Thunnus thynnus collected in the Slope Sea in July 2013.  
Photo: Katey Marancik.*

collected during both of these efforts is ongoing.

Baglin R. E. 1976. A preliminary study of the gonadal development and fecundity of the western Atlantic bluefin tuna. Col. Vol. Sci. Pap. ICCAT 5:279-289.

Richardson D. E., Marancik K. E., Guyon J. R., Lutcavage M. E., Galuardi B., Lam C. H., Walsh H. J., Wildes S., Yates D. A., and Hare J. A. 2016. Discovery of a spawning ground reveals diverse migration strategies in Atlantic bluefin tuna (*Thunnus thynnus*). Proceedings of the National Academy of Sciences. 113: 3299-3304.

--David Richardson §

*Southern Region ...cont'd from p. 8*

enzyme activities of the fish using standard assays. I will target enzymes used in protein, carbohydrate, and lipid metabolism, including pepsin, trypsin, α-amylase, and lipase.

Based on daily examination of catfish, all fry began feeding exogenously at 5–7 days old, at which time I could see food in intestinal loops. In Experiment 1, both Channel and hybrid catfish grew faster in length and weight when provided zooplankton plus commercial feed as compared to zooplankton alone. However, there were no differences in

growth rate between catfish type within each diet treatment. In Experiment 2, Blue and hybrid catfish grew faster in length and weight than Channel Catfish, although the Channel Catfish were smaller from hatching. I have yet to determine the effects of feeding on live prey selection and digestive enzyme ontogeny.

By understanding how commercial feeds affect early-life diets and digestive ontogeny of catfish, I hope to provide hatchery managers specific recommendations to improve production reliability. I am especially interested in determining if providing

catfish access to live prey and commercial feed from the onset of exogenous feeding is a necessary practice, and if so, determining when managers should stock fry into nursery ponds. Results from these experiments will also contribute to a more general understanding of the importance of early-life diet quality for recruitment of any species into hatchery or wild populations.

--Jesse E. Filbrun, Department of Biology, Southern Arkansas University §



## In Memoriam Dr Allan Connell

Dr Allan Connell, who passed away while diving off Durban, South Africa in March 2016, was an enthusiastic diver and investigator of the early-life history of fishes. He was employed at the South African Council for Scientific and Industrial Research for over 35 years, where he worked with the Coastal Systems Group, but Allan is best known by ELHS members for his work on fish eggs and larvae of the subtropical east coast of South Africa. Lynnath Beckley introduced me to Allan during my visit to South Africa in 1992. In the garden shed of his home, overlooking the Indian Ocean just south of Durban, Allan was – in his spare time - rearing fish from pelagic eggs he had captured by streaming a net off the stern of his boat while he dived offshore. He was remarkably adept at rearing the larvae, and had amassed an impressive collection of beautiful colour photographs of the eggs and larvae he had reared. I was (and still am) amazed and impressed by what he had done on his own and in his spare time. He retired from CSIR in 2004, by which time he had started putting his acquired knowledge of SA fish eggs and larvae - fully illustrated in colour - on the web so others could benefit from his work. Allan subsequently collaborated with the Barcode of Life team to confirm the identities of many of his reared specimens using genetic methods. Allan could claim the first identification of eggs and larvae of many species, and even higher taxa, all documented on his website. In addition to his descriptions of larvae, Allan also collected and posted information about seasonality of spawning based on the abundance of the eggs he captured both offshore and in the mouth of Durban Harbour. This made his website doubly valuable. The website abstract is reproduced below (<http://fisheggs-and-larvae.saiab.ac.za/Default.htm>).

Allan and his contributions to our science will be sorely missed. One only hopes that someone will take over and maintain his website as a fitting tribute to a person who loved the ocean, diving and fish eggs and larvae!

Marine fish eggs and larvae from the east coast of South Africa by Allan Connell, Durban, South Africa.

Twenty-five years of records are summarised, in 226 separate species data sheets, on eggs and early larvae of fishes spawning pelagic eggs on the inshore shelf, within 5 km of the coast, along a short section of the KwaZulu-Natal coastline, about 50 km south of Durban. Annual



spawning period, and egg abundance trends over the 25 years, are provided, as well as egg and larval descriptions, showing the ephemeral pigment patterns of many species' early larvae, in digital image colour. By collecting both offshore (5 km) and inshore (0.5 km) samples, comparing percentage representation of each species within these two sample sets, and using two indicator species, the kob *Argyrosomus japonicus* and the geelbek *Atractoscion aequidens*, both with well-defined spawning grounds, a reasonable assessment of location of spawning was obtained for all the common eggs in the study area. About 65 species were reared on a simple food-chain for identification purposes, but in the latter stages of the study, larval identification

was by DNA bar-coding using the cytochrome C1 gene. The study is ongoing, both to increase the annual trend graphics for each species, and to gather barcodes of currently unidentified eggs and larvae, so that they will be identified when adult material has been sequenced, in support of which, over 900 species of local marine fishes have been bar-coded. Introductory Notes describe the geography and oceanography of the study area, with particular emphasis on how these affect spawning migrations of species into the study area, and movement of early juveniles to their preferred nursery areas.

--Jeff Leis, Australian Museum Research Institute and Institute for Marine and Antarctic Studies, University of Tasmania §



A larva of the sole, *Aseraggodes heemstrai*, reared and photographed by Allan Connell. Downloaded from his website.

## People



*Tom Simon, faculty photo, Indiana University.*

## In Memoriam Dr. Thomas P. Simon

Our colleague, Tom Simon, passed away unexpectedly at the age of 57 on 16 July 2016 (obituary: <http://www.obitree.com/obituary/us/indiana/bloomington/the-funeral-chapel/thomas-simon-phd/2649614/>). An expert on freshwater fishes and their larvae in north-central United States, Tom had long emphasized fish early life history in his research, teaching, and many publications. He has described the larvae of many species, especially darters (Percidae); co-edited with Robert Wallus, and authored portions of, most of the guides to the Reproductive Biology and Early Life History of Fishes on the Ohio River Drainage (1990-2008, volumes 1-6; he and Bob were working on the final volumes covering the family Cyprinidae); edited, and authored portions of, Assessing the Sustainability and Biological Integrity of Water Resources Using Fish Communities (1999), and edited, authored, or co-authored several related books and many related articles; and more recently, authored a book on the Fishes of Indiana (2011). He helped establish and directed the Indiana Biological Survey Aquatic Research Center (Bloomington, Indiana; <http://www.indiana.edu/~inbsarc/>) and curated its collection of fishes which includes over 59,000 lots of larval fish (about 14 million specimens), in part from his former Large Rivers Station Collection and the Tennessee Valley Authority early life history reference collection. And he served as editor of our AFS Early Life History Section Newsletter for five years from 1990 through 1994. We will indeed miss Tom and his enthusiasm for and contributions to the early life history of freshwater fishes.

--Darrel Snyder, Larval Fish Laboratory, Colorado State University §

## Recent events

## Larval Fish Conference in Solomons, Maryland

The 40<sup>th</sup> annual Larval Fish Conference, organized by Tom Miller and Dave Secor was a great success. There were 110 delegates from 22 countries at the conference. The meeting was hosted by the Chesapeake Biological Laboratory in Solomons Maryland, on a return visit after 32 years. The 2016 LFC honored Dr. Edward Houde, Professor at Chesapeake Biological Laboratory and pioneer in fish recruitment studies. Keynote addresses and theme sessions at the LFC paid tribute to Ed's diverse contributions to larval fish ecology, including;

Maternal Effects and Beyond

Carry over of early life

ELHS of Large Pelagics

Larval Dispersal

ELHS in Marine Food Web

This comprehensive schedule was made possible through the support and work of many colleagues from the scientific committee. Our thanks go to Sue Sogard, Dan Margulies, Ed Rutherford, Elizabeth North, Ed Roseman, Pierre Pepin, Jim Cowan, David Johnson, Jeff Leis, Peter Konstantinidis and Nalani Schnell.

Altogether 74 oral presentations and 35 posters were scheduled. The competition for the Sally L. Richardson award for the best oral presentation included 18 students.

A workshop was organized by the Early Careers Scientists Alison Deary, Matthias Paulsen, Marta Mayano, and Hannes Baumann, and was very well received by many participants.

We very much enjoyed hosting this meeting of the ELHS and welcoming so many colleagues from all around the world!

-- Tom Miller and Dave Secor §



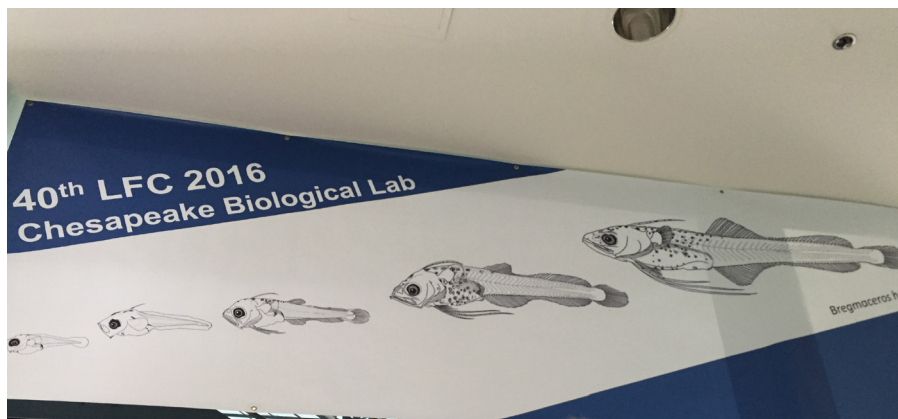




*Edward Houde with collaborators.*



*Winners of the new flag.*



*Impressions from the 40th LFC in Solomons, Maryland.*





## Fishy shirts



### *Fishy shirts worn at 40th LFC*

Many of you are showing the most wonderful fishy shirts when at the LFC. Do you save these for meetings, or wear them at other occasions as well? Send us your fishy shirt poses or selfies to add to our collection.

--Editors §



### *President's Message...cont'd from p. 1*

Having said that, we still need a member or two who are dedicated (or brave?) enough to step up and run for the office of President-Elect. Of course the President-Elect will take the office of President after two years, and having been the ELHS President for all of 3 months now, I can honestly say, "It's awesome--you should totally consider it!!"

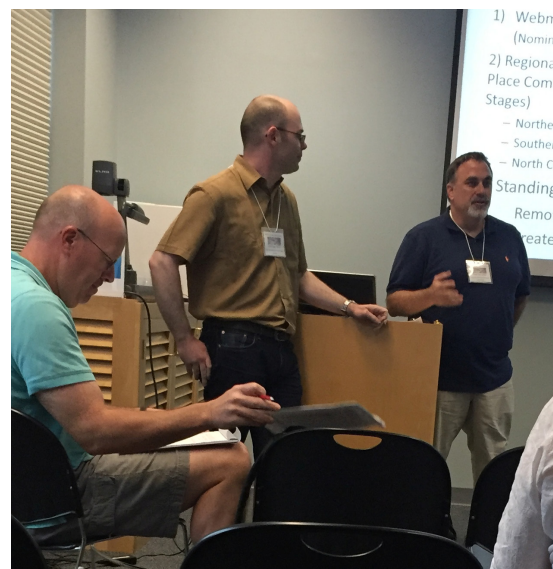
In all seriousness, the section needs your support. Anyone interested in running for President-Elect or perhaps nominating someone, please let me know. It is an important position, as the longer it remains empty, the longer we are without a full Executive Committee. We hope to have the online elections for these vacancies this fall, so stay tuned. Full members of the ELHS with voting privileges will be called on to cast your ballots.

Another way in which our members contribute to the success of the section is through their generosity towards our various student awards, and this year was no exception. Your contributions at the 2016 Larval Fish Conference for the raffle and the flag auction resulted in over \$1,000 for the Sally Richardson Award fund and over \$1,500 for the John H. S. Blaxter Award fund! That is incredible, and I think it speaks volumes about how our members value student participation. Shortly after the meeting, Secretary Jeff Buckel also informed me that we received an anonymous donation to the Grace Klein McPhee fund in the amount of \$5,300! Again, just an incredible display of generosity, and on

behalf of the section I thank you (whoever you are!).

And speaking of the Larval Fish Conference, it's hard to believe that it's already been three months since many of us were together at the Chesapeake Bay Biological Laboratory doing what many of us love doing best--talking about tiny fishes, catching up with old friends and colleagues, and making new ones. If you haven't noticed, the ELHS has quite the international flavor of late, which I find very exciting. This year's meeting coincided with an interesting point in history. Major events of international interest were on the horizon, which made for great coffee break and hotel bar conversations. It is hard to say which delegation suffered the most fatigue--the Americans fending off questions about our pending presidential elections ("Is he really going to be your president?!"), or our Brazilian colleagues responding to questions about their country's readiness for the Olympic games. Never a dull moment!

I mention all of this as a reminder that next year's Larval Fish Conference (our 41st) will be held in Austin, Texas (July 12-16, 2017) with the Joint Meeting of Ichthyologists and Herpetologists. I can't say at this moment what world event will dominate our conversations during the breaks. But, I am comfortable saying that it is sure to be a great meeting (as always) and I look forward to seeing many of you there. Chris Chambers



*New President and Secretary take the stage at the 40th LFC.*

and Lee Fuiman have generously agreed to serve as points of contacts for the meeting, and details will be forthcoming. Here in the U.S., we know Austin as the state capital of Texas, the "Live Music Capital of the World", and our 11th largest city. However, it was brought to my attention at this year's Larval Fish Conference that many of our international members know relatively little about Austin. Perhaps in the next issue of STAGES, I will devote a portion of the President's message to extolling the virtues of our next meeting venue, so stay tuned.

Best regards from the southern U.S.,

— Frank Hernandez, President (and registered "Independent") §



## Newsletter Production Team

**Stages** is published in February, June, and October each year. It is assembled by the Newsletter Editor with contributions from several Regional Representatives and other individuals. Please send any articles, announcements, or information of interest to Early Life History Section members or affiliates to your local Regional Representative or to the Editor.

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## Join ELHS

Membership in ELHS is open to all persons or organizations interested in furthering ELHS objectives, regardless of membership in the American Fisheries Society (AFS). If you are an AFS member, simply add ELHS membership when you pay your Society dues.

Affiliate membership is open to persons or organizations who are not members of AFS. Affiliate members are encouraged to participate in Section meetings, committee work, and other activities, but they cannot vote on official Section matters, run for or hold an elected office, or chair standing committees. All members receive **STAGES**.

ELHS has a PayPal account to receive affiliate membership dues. To join ELHS as an affiliate or to renew affiliate status online, go to: <http://earlylifehistory.fisheries.org/how-to-join/> or mail your name, institutional affiliation (if appropriate), mailing address, telephone and fax numbers, e-mail address, and dues (US \$15 per year) for the current and/or upcoming year(s) to the ELHS Treasurer (see page 2).

Please specify the membership year(s) for which you are paying dues. Make checks or money orders payable to "AFS-ELHS."

## Editor's Ramblings



It is always a shock and a relief to get back into a routine after summer, and by the end of October it seems that all the signs of autumn are in place. It has been encouraging to see new notices of job vacancies for scientists with expertise in larval fish and early life history, signs of new programmes in a number of different countries. We can also use our section network outlets to spread the word of new opportunities –

both facebook: [@earlylifehistory](https://www.facebook.com/earlylifehistory/) - (<https://www.facebook.com/earlylifehistory/>)

and twitter: [@AFS\\_ELH](https://twitter.com/AFS_ELH), thanks to Todd Clardy ([@ToddClardy](https://twitter.com/ToddClardy))

After many years of watching a truly awesome display of sartorial fishiness at conferences, we've decided to start recording this aquatic diversity in a more systematic way. So in this issue we've presented a small selection of fishy shirts from the LFC banquet. Look out for the whole collection – which will certainly require some taxonomic work and proper curating.

We've had a great response with regional reports and material for this issue, and hope that you'll find it informative and inspiring. You don't have to wait for the next deadline (January 13th, 2017) to submit content – send it in anytime to your regional representatives or directly to us here at **STAGES**.

Best wishes, from  
Cindy & Audrey §