FINAL PROJECT REPORT

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Current status of the Key silverside, *Menidia conchorum*, in southern Florida

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Summary

The status of the Key silverside, *Menidia conchorum* has been of concern because of its extremely restricted range and narrow habitat requirements. In recent years, *M. conchorum* has been reported only from isolated, hyper-saline lagoons on the lower Florida Keys. About 25 years have passed since the last attempts to describe the distribution and abundance of this species. The sites where *M. conchorum* were previously found have since become developed, are subject to future development, or fall within the boundaries of National Wildlife Refuges and State Parks. To assess the current geographic distribution and status of *M. conchorum*, a field survey encompassing the known range of *M. conchorum* in the Lower Florida Keys (and beyond) was conducted in Feb 1999. We collected a total of 2,680 specimens of *M. conchorum* at 15 of the 29 sites sampled. All but one of the sites where *M. conchorum* was found were semi-enclosed, shallow, tidal lagoons with salinities in excess of those found at sites where tidal exchange was unrestricted. Where found at such sites, *M. conchorum* was generally abundant with catch rates typically ranging from 25 to 225 fish per seine haul. All but two of the sites where *M. conchorum* was found were on the Lower Keys, but we also collected specimens identified as either *M. conchorum* or *M. peninsulae* at one site on Key Largo and at a mainland site north of Key Largo. Our survey suggests that *M. conchorum* continues to prosper in the limited range and habitat in which it is found. However, serious doubts about the taxonomic status of *Menidia conchorum*, regarding its validity as a species, need to be resolved.

Introduction

The Key silverside, *Menidia conchorum* (Pisces: Atherinidae), is one of a very few marine fish species endemic to the lower Florida Keys. In body size, it is the smallest (50-60 mm total length) of the three members of the genus *Menidia* found in southern Florida, the others being the tidewater silverside, *Menidia peninsulae*, and the inland silverside, *Menidia beryllina*. The Key silverside is a schooling fish residing in shallow, enclosed, hypersaline lagoons.

The status of this fish has had a confused history that remains unresolved. Although described as being "not uncommon in the shallow water around Key West" in the original description of the species in the 1920s (Hildebrand and Ginsburg 1927), studies in the 1970s found the species to be restricted to only a few semi-isolated saline lagoons or ponds that receive limited tidal exchange. These lagoons occur on Long Key, Grassy Key, Big Pine Key, Cudjoe Key, Boca Chica Key and Key West. During extensive sampling in 1974-75, Getter (1981) found *M. conchorum* at 20 such lagoons and ponds, but believed the species to be in danger of extinction due to its extremely limited range, narrow habitat requirements, and the potential for loss of remaining habitat due to filling and development by humans. Because of its extremely limited geographic distribution and habitat requirements, the Key silverside was classified by the Florida Committee on Rare and Endangered Plants and Animals, or FCREPA (Gilbert 1978) as an endangered species. The Florida Natural Areas Inventory currently lists the Key silverside as "globally imperiled", and it is listed by the Florida Game and Fresh Water Fish

Commission as a "threatened" species (Wood 1996). *M. conchorum* has been a candidate for designation as an endangered species on the U.S. federal list for several years.

Duggins et al. (1986) presented evidence that the Key silverside was genetically indistinguishable from *Menidia peninsulae* (based on allozyme variation). Although acknowledging that the two species differ morphologically to an extent that would normally be considered as distinct species, they suggested that the unique morphology of the Key silverside was ecotypic and caused by environmental rather than genetic differences. Duggins et al. (1986) further suggested that the apparent rarity of the Key silverside in southern Florida was merely due to inadequate sampling, yet they were unable to collect the species outside of lagoons on the lower Florida Keys. The most recent assessment by the FCREPA Committee downgraded the status of the Key silverside to that of a "Species of Special Concern" (Gilbert 1992), primarily based on the findings of Duggins et al. (1986).

Since the 1970s collections by Getter (1981) and Duggins et al. (1986), no efforts to assess the status or species validity of the Key silverside have been conducted or published. Gilbert (1992) recommended that Key silverside populations be periodically monitored to ensure that additional habitat degradation has not occurred, and that efforts be made to locate other populations. The purpose of this study is to assess the current distribution and abundance of *M. conchorum* in southern Florida. We report on the occurrence of *M. conchorum* at 29 sites encompassing the region from the coastal

mainland of Southeast Florida to Key West, and including Upper Key Largo. These locations include the sites where *M. conchorum* was found earlier by Getter (1981) and Duggins et al. (1986) and virtually all other sites on the Florida Keys where suitable habitat exists.

Methodology

Field Collections: Before collecting began, aerial photographs were used to identify all enclosed lagoonal habitats on the Florida Keys that were accessible by vehicle and were likely to contain *M. conchorum*. Most of these sites were selected for sampling (n=21). For comparative purposes, a number of other shallow open-water sites where tidal flow was unrestricted (n=8) were also sampled. Table 1 provides a list of the location and lat./long. for each site. The sampling also included sites on the Upper Florida Keys and lower mainland sites (along U.S. 1) where unidentified *Menidia* spp. were known to occur (W. Loftus, pers. comm.). All sites were visited once during the period Feb. 20-26, 1999, the middle of the breeding season for *M. conchorum*. All sampling was conducted with 100 ft small-mesh beach seine set from the shore by wading to a depth of about 0.5-0.75 m. Two separate hauls of the seine were conducted at each site. All fish collected were identified to species and enumerated. Water temperature, salinity, and pH were recorded at each site. Most specimens were released unharmed. Limited samples of specimens were preserved in alcohol from each site for later analysis of size frequency, sex ratio, and morphology. Collections were made under U.S. Fish and Wildlife National Key Deer Refuge Permit # 41580-99-003 and Florida Dept. of Environmental Protection Permit # 99S-393 to Dr. David Conover (Appendix 1).

The primary technique for distinguishing the various species of *Menidia* is through meristic counts of the number of vertebrae, anal fin rays, and the various other morphometric measures (see Chernoff et al. 1981). To separate *M. conchorum* from *M beryllina* in the field, we relied on the transparency and caudal extension of the gas bladder (Echelle and Mosier 1981) and the number of anal fin rays (Duggins et al. 1986). We confirmed these field distinctions by counting from X-ray photographs the total number of vertebrae and the number of vertebrae found between the origins of the spinous dorsal and anal fins (Chernoff et al. 1981). There are no simple criteria for distinguishing *M. conchorum* from *M. peninsulae,* which is part of the reason why species validity is in doubt. In keeping with past authors, we refer to specimens of the *M. conchorum/peninsulae* type that come from the Florida Keys as *M. conchorum*. Specimens of *M. peninsulae* have not been reported south of Marco Island on the west coast or Ft. Pierce on the east coast of Florida. The identity of *M. conchorum /peninsulae* types that come from the lower Florida mainland (i.e., north of the Keys and south of the southernmost collections of *M. peninsulae*) is thus problematic.

Results

We collected a total of 2,680 specimens of *M. conchorum*, which were collected at 15 of the 29 sites sampled (Table 1). All but one of the sites where *M. conchorum* was found were semi-enclosed shallow tidal lagoons with salinities in excess of those found at sites where tidal exchange was unrestricted (Tables 2 and 3). Salinities at *M. conchorum* sites ranged from 20 to 56 $^{o}/_{oo}$ and averaged 41 $^{o}/_{oo}$, whereas salinities at sites lacking *M. conchorum* averaged 38 $^{o}/_{oo}$ (Table 4). Temperature and pH were somewhat higher and

water depth was generally shallower at *M. conchorum* sites than at locations were *M. conchorum* was absent. Size frequency distributions of the fish were fairly similar among sites (Fig. 1). Lengths of both sexes ranged from 20-55cm at most locations with a mean of about 25-35cm. Fish were somewhat larger at Big Torch Key and Cudjoe Key (45-50cm in mean length). Length distributions were generally unimodal, suggesting that they were the product of single spawning season, although a bimodal size distribution was evident at one of the Big Pine Key sites. The sex ratio varied greatly among sites, ranging from .08 to .68 (F/F+M).

Where found, *M. conchorum* was generally abundant with catch rates typically ranging from 25 to 225 fish per seine haul (Table 1). All but two of the sites where *M. conchorum* occurred were on the Lower Keys, but we also collected fish that were either *M. conchorum* or *M. peninsulae* (see Discussion) at one site on Key Largo and at a mainland site north of Key Largo (Highway Creek). On North Key Largo, an abundant population of *Menidia beryllina* was found in Crocodile Lakes.

M. conchorum was generally found in association with an assemblage of fishes that included various killifishes (mostly *Floridichthys carpio;* but also *Cyprinodon variegatus*, *Fundulus similis* and *F. grandis*), various juvenile mojarras (Gerreidae), needlefishes (*Strongylura notata* and *S. marina*) and poecilids (mostly *Poecilia latipinna)* (Table 4). The dominant vegetation at *M. conchorum* sites was *Cladophora.* A complete list of fishes collected is presented in Table 5.

Discussion

Our survey suggests that small populations of *M. conchorum* prosper in the limited range of habitats in which they are found on the Lower Keys. We collected far more specimens of *M. conchorum*, and at more sites, than did Duggins et al. (1986), who collected 249 specimens at 5 localities. We found *M. conchorum* at somewhat fewer sites than did Getter (1981), who collected an unknown number of specimens at 20 localities. Overall, there appears to be little evidence of progressive decline in the abundance of the species on the Florida Keys. However, it is clear that *M. conchorum* has very narrow habitat requirements, being restricted almost entirely to shallow, enclosed, hypersaline lagoons. We visited nearly all such lagoons that exist on the Keys and are accessible by road. It is likely there are other closed lagoon sites that also contain *M. conchorum* on outlying islands not connected to U.S 1. Nonetheless, lagoon sites are few in number and subject to development where found on private property.

Serious doubts about the taxonomic status of *Menidia conchorum*, especially regarding its validity as a species, need to be resolved. Is it a valid species, distinct from all other *Menidia* spp., or just an ecotype of *Menidia peninsulae? M. conchorum* was originally described by Hildebrand and Ginsburg (1927). They distinguished it from other *Menidia* spp based on its low anal fin ray number. In morphology, it closely resembles *M. peninsulae* and *M. beryllina.* Duggins et al. (1986) concluded that *M. conchorum* and *M. peninsulae* were conspecific based on similarity in allozymic variation, even though meristic characters differed to an extent that would warrant designation as distinct species under traditional taxonomy. However, the variation in meristics among

the *M. conchorum/peninsulae* complex may represent merely a latitudinal cline; there are no morphological features that are clearly diagnostic for the two species (Duggins et al. 1986).

M. peninsulae has been found as far south as Marco Island on the Florida west coast (Duggins et al. 1986). Whether it occurs continuously along the southwestern coast of Florida to the Upper Florida Keys is unknown. Getter (1981) tentatively identified specimens of *Menidia* from North River (Whitewater Bay), Buttonwood Canal (Flamingo) and a Key Largo site as *M. peninsulae*. *M. conchorum* has never been collected north of Long Key. Hence, the identity of the *Menidia* we captured on Key Largo and the mainland Highway Creek site is problematic. Based on the caudal extension of the gas bladder (Echelle and Mosier, 1981) and number of vertebrae between the spinous dorsal and anal fins (Chernoff et al, 1981), they were clearly not *Menidia beryllina*. Either these specimens represent a northern extension of the reported range of *M. conchorum*, a southern extension of the range of *M. peninsulae*, or an indication that all such forms represent a continuous distribution of one species as argued by Duggins et al. (1986). Additional studies of the distributions of *M. conchorum* and *M. peninsulae* along the Florida west coast are needed to address this issue.

The species validity question could be resolved by molecular genetic analyses of sequence data from mitochondrial and/or nuclear DNA. The ecotypic basis of morphological variation, whether caused by genetic variation or phenotypic plasticity,

could be investigated through the use of common garden experiments wherein progeny from different localities are reared in identical environments (Conover and Schultz 1995).

Genetically-based variation in growth rate of *M. conchorum* and *M. peninsulae* was found in common-garden experiments conducted in 1997-98 by K. Yamahira and D.O. Conover (unpublished data). Specimens from this experiment could also be used to identify whether morphological trait variation in *M. conchorum* vs. *M. peninsulae* has a genetic basis; preliminary analyses suggest to us that at much of the morphological variation is genetic (D.O. Conover, unpublished data).

Recommendations

Resolution of the species question is paramount because it has important management implications. *M. conchorum* is being considered as a candidate for the U.S. federal endangered species list, and has been listed by the Florida Game and Freshwater Fish Commission as a threatened species. There are three possibilities regarding the taxonomic status of *M. conchorum*, each with different implications for management, as follows.

1. **If *M. conchorum* is a valid species**, then the few sites where the species is currently found deserve some form of protection from habitat alteration, regular monitoring of local populations for trends in abundance, and research to provide a better understanding of life history and habitat requirements. In particular, the enclosed, tidally restricted

nature of these systems should be maintained. We suspect that, when these tidally restricted lagoons become reconnected to open water, *M. conchorum* is quickly replaced by the hardhead silverside, *Atherinomorus stipes*. Because of its extremely limited range, designation as a threatened or endangered species would probably be justified.

2. If instead, *M. conchorum* is a subspecific genetic variant of *M. peninsulae*, thereby representing an evolutionary significant unit (ESU) below the species level, some level of protection may still be warranted. This would be especially true if the distribution of the Key silverside is disjunct with that of *M. peninsulae* such that re-colonization of local habitats would be unlikely.

3. However, if the characteristics of *M. conchorum* are purely environmental in origin, and/or represent merely the southern extreme of the range of *M. peninsulae*, then there would be little justification for any special measures of protection and the Key silverside population could be removed from state and federal lists of threatened or endangered species.

Given the three possibilities defined above, we recommend the following research efforts be undertaken:

1. Conduct mitochondrial and nuclear DNA studies to verify the taxonomic status *of M. conchorum* as distinct from *M. peninsulae*.

2. Conduct common-garden experiments comparing physiology (e.g., growth, temperature and salinity tolerance, etc) of *M. conchorum* and *M. peninsulae* to test whether populations of *M. conchorum* are uniquely adapted to the Florida Keys environment and thus constitute an ESU.

3. Conduct field survey of *Menidia* spp. along the southwest coast of Florida between Marco Island and the Florida Keys to determine if the distributions of *M. conchorum* and *M. peninsulae* are continuous or disjunct, and whether morphological variation is clinal with respect to latitude.

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Table 1. Sites sampled by Marine Sciences Research Center and the number of *M. conchorum* collected per seine haul.

Key	Station Location	Date	Latitude	Longitude	M. conchorum Haul 1	M. conchorum Haul 2
Grassy Key	Tropical Ave	2/20/99	24 45.317	80 57.770	149	42
Big Pine Key	Newfound Rd	2/20/99	24 39.923	81 21.796	52	0
Little Torch Key	Heck Ave	2/21/99	24 40.362	81 23.394	22	136
Big Pine Key	Koehn Ave	2/21/99	24 42.986	81 22.519	0	2
Big Pine Key	Koehn Ave Boat Ramp	2/21/99	24 43.152	81 22.497	0	0
Big Pine Key	No Name Rd	2/21/99	24 43.636	81 23.753	0	0
No Name Key	Borrow Pit	2/21/99	24 42.057	81 19.863	13	0
Big Pine Key	Maintenance Area	2/21/99	24 41.445	81 22.834	156	88
Big Pine Key	Long Beach Rd	2/21/99	24 38.470	81 20.410	0	0
Big Torch Key	Lagoon, Dorn Rd	2/22/99	24 41.455	81 24.949	0	0
Big Torch Key	West of Dorn Rd	2/22/99	24 41.725	81 25.508	45	6
Ramrod Key	Indies Rd west side	2/22/99	24 39.239	81 24.426	0	0
Cudjoe Key	Cutthroat Rd	2/22/99	24 39.986	81 28.959	231	19
Cudjoe Key	Blimp Rd East Side	2/22/99	24 40.544	81 29.962	82	67
Sugarloaf Key	Off Sugarloaf Blvd	2/22/99	24 36.894	81 33.253	78	2
Rockland Key	US 1 mile 9 south side	2/23/99	24 35.383	81 40.608	209	60
Boca Chica	US 1 north side	2/23/99	24 35.075	81 42.004	296	161
Key West	South of Airport	2/23/99	24 33.186	81 45.660	50	471
Rockland Key	US 1 north side	2/23/99	24 35.383	81 40.608	0	0
Saddle Bunch Key	US 1 south side	2/23/99	24 36.900	81 37.050	0	1
Cudjoe Key	Blimp Rd - open Bay	2/23/99	24 39.986	81 28.959	0	0
Ohio Key	Trailer Park	2/24/99	24 40.382	81 14.664	0	0
Key Largo	Caribbean Ave	2/24/99	25 1.709	80 29.893	0	0
Key Largo	Park Dr	2/25/99	25 6.749	80 25.778	0	0
Key Largo	Lake St	2/25/99	25 7.625	80 24.810	190	0
Barnes Sound	US 1 East Side	2/25/99	25 13.426	80 25.851	0	0
Card Sound	North of FL 905A	2/26/99	25 17.088	80 21.660	0	0
Crocodile Lakes	North side	2/26/99	25 17.084	80 18.558	0	0
Highway Creek	US 1 west side	2/26/99	25 14.963	80 26.173	3	49
				Total		2680

Table 2. Number of sites where *M. conchorum* was found in semi-enclosed, tidally restricted lagoons vs. open sites with unrestricted tidal flushing.

	Present	Absent
Closed	15	6
Open	1	7
	χ^2 test: p = 0.004	
CPUE in closed sites		63.79
CPUE in open sites		0.06

Table 3. Physical Characteristics of the Sampling Sites

ID	Key	Time	Salinity (ppt)	Temperature (°C)	pH	Depth (cm)	Open to Ocean	*M. conchorum* present
1	Grassy Key		31	29	7.8	60	N	Y
2	Big Pine Key	1710	48	28	8	60	N	Y
3	Little Torch Key	845	39	21	8	60	N	Y
4	Big Pine Key	945	40	21.5	8	60	N	Y
5	Big Pine Key	1100	35	21	7.4	90	Y	N
6	Big Pine Key	1130	42	23	8	38	N	N
7	No Name Key	1400	30	26	8.2	45	N	Y
8	Big Pine Key	1500	37	28	8		N	Y
9	Big Pine Key	1600	36	25			Y	N
10	Big Torch Key	915	45	18.5	8.4		Y	N
11	Big Torch Key	1020	45	18	8.4	90	N	Y
12	Ramrod Key	1130	62	20	8.2	50	N	N
13	Cudjoe Key	1330	56	23.5	8.4	50	N	Y
14	Cudjoe Key	1400	47	23	8.2		N	Y
15	Sugarloaf Key	1630	48	20	8.4	45	N	Y
16	Rockland Key	945	46	18.5	8.2	40	N	Y
17	Boca Chica	1115	54	20		45	N	Y
18	Key West	1415	44	23	8.4	30	N	Y
19	Rockland Key	1515	5	24	8	45	N	N
20	Saddle Bunch Key	1600	40	24.5	8.2	50	Y	Y
21	Cudjoe Key	1700	45	23	8.4	60	Y	N
22	Ohio Key	1030	48	20	8	30	N	N
23	Key Largo	1215	38	20	8	100	Y	N
24	Key Largo	1355	35	25	8	30	N	N
25	Key Largo	1530	38	24	8	75	N	Y
26	Barnes Sound	1700	30	22	8	100	Y	N
27	Card Sound	740	40	17	8.2	100	Y	N
28	Crocodile Lakes	945	30	19	8	50	N	N
29	Highway Creek	1330	20	21.5	8	90	N	Y

Table 4. **Habitat Characteristics of sites with and without *M. conchorum*.**

	M. conchorum **Absent**		*M. conchorum* **Present**	
Physical Variables	**Average Value**		**Average Value**	
Salinity	37.77		41.44	
Temperature	21.35		23.09	
pH	8.05		8.15	
Depth	63.00		57.14	
Vegetation	**Number of Sites**		**Number of Sites**	
Cladophora	3		11	
Acetabularia	2		3	
Penicillus	2		1	
Udotea	0		1	
Halimeda	4		1	
Halodule	1		2	
Thalassia	4		3	
Other Species	**CPUE**	**# of Sites**	**CPUE**	**# of Sites**
Atherinomorus stipes	209.85	4	22.77	3
Floridichthys carpio	96.92	7	307.08	12
Cyprinodon variegatus	62.62	5	54.46	9
Menidia beryllina	37.46	2	0.00	0
Eucinostomus spp.	23.38	6	97.15	12
Strongylura sp.	18.15	9	36.85	12
Poecilia latipinna	17.38	4	22.23	4
Gambusia holbrooki	6.62	2	0.00	0
Lagodon rhomboides	2.69	2	0.31	1
Fundulus similis	2.08	1	9.38	8
Adinia xenica	2.08	1	0.00	0
Lucania parva	1.23	2	0.46	4
Sphyraena barracuda	0.31	2	0.00	1
Sphoeroides sp.	0.23	1	0.00	0
Chryodorus atherinoides	0.15	1	0.00	0
Microgobius sp.	0.08	1	0.00	0
Syngnathus sp.	0.08	1	0.08	1
Fundulus grandis	0.00	0	2.54	5
Lophogobius cyprinoides	0.00	0	0.08	1
Synodus sp.	0.00	0	0.15	1
Portunid crab	0.00	0	0.23	1
Penaeid shrimp	0.00	0	0.15	1

Appendix 1. Copies of Letters and Collecting Permits from the U.S. Fish and Wildlife Service's National Key Deer Refuge and the Florida Department of Environmental Protection that allowed the collection of *Menidia conchorum* in 1999.