FINE SCALE SPATIAL VARIATION IN TOTAL MERCURY LEVELS IN MOLLUSCAN BIVALVES FROM SOUTHWEST FLORIDA

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Abstract: Methylmercury production and biomagnification is known to be spatially highly variable leading to "hot spots". In South Florida, regional variability in methylmercury biomagnification has been shown from finfish surveys along the coast, done by others. The objective of this study is to use molluscan bivalves, either sedentary or with very limited home ranges, to better assess the fine scale spatial variation in mercury availability. A secondary objective was to begin to assess the potential species-specific differences in mercury accumulation of different bivalve species including the Eastern Oyster (*Crassostrea virginica*) and Calico Scallop (*Argopecten gibbus*). While the former was principally sampled from estuaries, the latter was collected from nearshore coastal waters. Spatial patterns in measured total mercury concentrations will be presented and discussed in the context of results from other mercury monitoring programs in Southwest Florida.

Introduction:

Monitoring and assessment for the Comprehensive Everglades Restoration Plan (CERP) included biomonitoring mercury in finfish. Two different sentinel species, gray snapper (*Lutjanus griseus*) and crevalle jack (*Caranx hippos*), that were known to have different home ranges were selected in an attempt to track mercury bioaccumulation at different spatial scales in South Florida estuaries. It was assumed that snappers with smaller home ranges would provide information on small scale variation whereas the jacks with larger ranges would integrate methylmercury availability on a regional scale.

The objective of this study was to validate those assumptions by examining fine-scale spatial variation in mercury accumulation in bivalves that are either sedentary or have very limited home ranges.

Methods:

Eastern oysters (*C. virginica*) and Calico scallops (*A. gibbus*) were collected in replicate (typically n = 5 for each collection) from five geographical areas of Southwest Florida from 2007-2008. Because distributions of these two bivalves did not overlap, Bay scallops (*A. irradians*) were collected from two sites that contained oysters. Most collections were samples of convenience during the first year and were frozen immediately. Most samples collected during the second year were purged in clean SW for 24 hours prior to freezing. To compare differences in treatments, oysters collected from San Carlos Bay sites S3 and S4 were each split; half the individuals were purged while the others were frozen immediately.

Samples were analyzed for total mercury (THg) by thermal decomposition, amalgamation and atomic absorption spectrophotometry using a Nippon Model MA-2000 (EPA method 7473); concentrations are reported on a wet weight basis (µg/kg). QC check samples during each run included continuing calibration verifications, blanks, duplicates, standard reference materials, and the certified reference material, DORM-3 (National Research Council Canada).

THg concentration datasets for Gray snapper (*L. griseus*) and Crevalle jack (*C. hippos*) collected in 2006 and 2007 under the CERP monitoring program were obtained for comparative purposes (David Evans, NOAA, personal communication). Fish size ranged from 183 to 338 mm in snapper and from 226 to 632 mm in jack. Fillet THg concentration in µg/kg wet weight was divided by total length of fish (mm) to normalize for fish size (Brumbaugh et al. 2001).

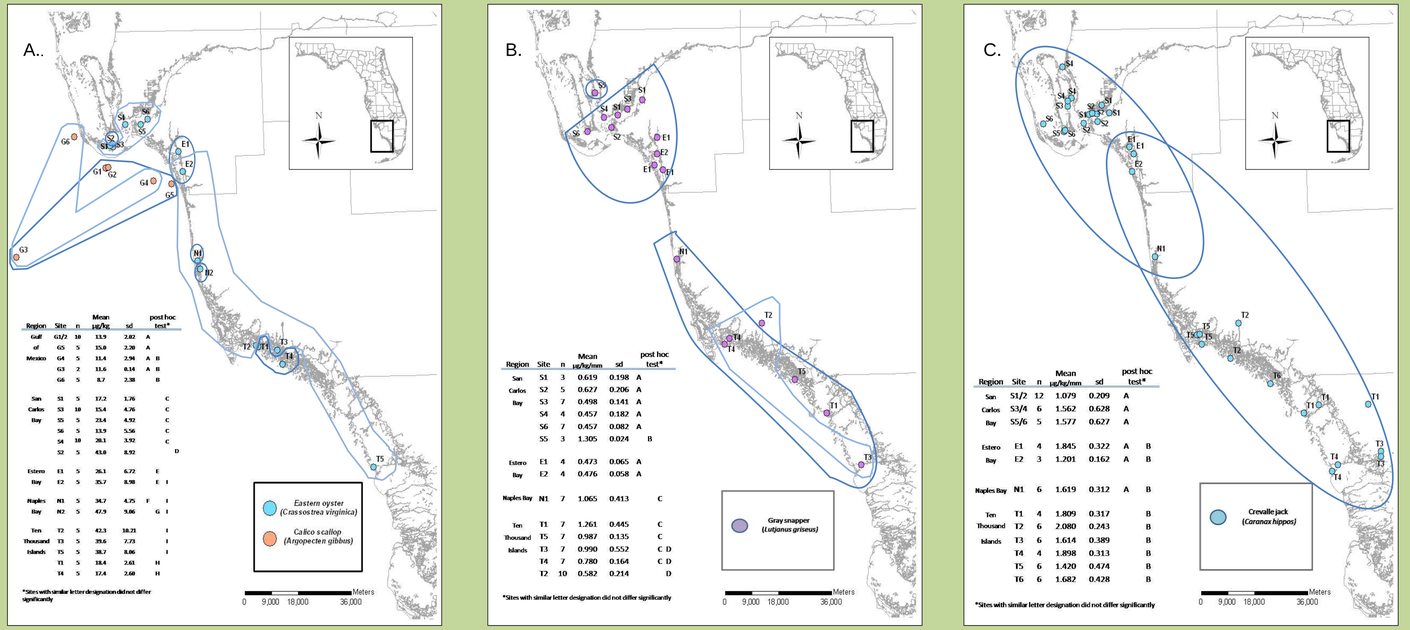
Results:

The correlation coefficient of initial calibration averaged 0.9988 (≥0.9972); deviation of continuing calibration verification check samples at end of run averaged 9.3% (<19.57%), reagent blanks contained on average 0.11 ng THg (<1.5 ng), recovery of internal SRMs averaged 90%; recovery in DORM-3 averaged 109% (ranged from 84% to 121%). Relative percent difference between duplicate analyses averaged 12.3% (ranged from 3.3% to 24.7%).

There was no significant difference between purged or non-purged oyster treatments (p=0.074), data were therefore pooled at S3 and at S4 for spatial comparisons.

Because distributions of calico scallops did not overlap oysters, species-related differences in Hg bioaccumulation could not be assessed. As a surrogate, Bay scallops were collected from two sites that contained oysters; bay scallops could not be found within the sampling area and were subsequently collected by FWC personnel in Sarasota Bay and Tampa Bay. Measured THg levels in tissues did not differ between species (p=0.902) or between locations (p=0.643).

Spatial patterns are shown in Figure 1.



Region	Site	n	Mean µg/kg	sd	post hoc test*
Gulf of Mexico	G1/2	10	13.9	2.02	A
	G5	5	15.0	2.20	A
	G4	5	11.4	2.94	A B
	G3	2	11.6	0.14	A B
	G6	5	8.7	2.38	B
San Carlos Bay	S1	5	17.2	1.76	C
	S3	10	15.4	4.76	C
	S5	5	23.4	4.92	C
	S6	5	13.7	5.56	C
	S4	10	28.1	3.92	C
	S2	5	43.0	8.92	D
Estero Bay	E1	5	26.1	6.72	E
	E2	5	35.7	8.98	E I
Naples Bay	N1	5	34.7	4.75	F I
	N2	5	47.9	9.06	G I
Ten Thousand Islands	T2	5	42.3	10.21	I
	T3	5	39.6	7.73	I
	T5	5	38.7	8.06	I
	T1	5	18.4	2.61	H
	T4	5	17.4	2.60	H

*Sites with similar letter designation did not differ significantly

Region	Site	n	Mean µg/kg/mm	sd	post hoc test*
San Carlos Bay	S1	3	0.619	0.198	A
	S2	5	0.627	0.206	A
	S3	7	0.498	0.141	A
	S4	4	0.457	0.182	A
	S6	7	0.457	0.082	A
	S5	3	1.305	0.024	B
Estero Bay	E1	4	0.473	0.065	A
	E2	4	0.476	0.058	A
Naples Bay	N1	7	1.065	0.413	C
Ten Thousand Islands	T1	7	1.261	0.445	C
	T5	7	0.987	0.135	C
	T3	7	0.990	0.552	C D
	T4	7	0.780	0.164	C D
	T2	10	0.582	0.214	D

*Sites with similar letter designation did not differ significantly

Region	Site	n	Mean µg/kg/mm	sd	post hoc test*
San Carlos Bay	S1/2	12	1.079	0.209	A
	S3/4	6	1.562	0.628	A
	S5/6	5	1.577	0.627	A
Estero Bay	E1	4	1.845	0.322	A B
	E2	3	1.201	0.162	A B
Naples Bay	N1	6	1.619	0.312	A B
Ten Thousand Islands	T1	4	1.809	0.317	B
	T2	6	2.080	0.243	B
	T3	6	1.614	0.389	B
	T4	4	1.898	0.313	B
	T5	6	1.420	0.474	B
	T6	6	1.682	0.428	B

*Sites with similar letter designation did not differ significantly

Figure 1. Map of collection sites in Southwest Florida of (A) Calico scallops and Eastern oysters (B) Gray snapper and (C) Crevalle jack. Because sometimes only 1 to 2 fish could be collected at a site; sites identified by the same number were grouped to increase sample size. Sample size (n), mean concentration (wet wt), and standard deviation (SD) are also shown by site. Among-site differences were determined by a one-way analysis of variance (ANOVA) followed by Tukey HSD post hoc comparison. Significance is based on a $p \leq 0.05$ criterion . Sites with similar letter designations (tabulated) did not differ significantly; sites that were not dissimilar are circled.

Discussion:

As expected, spatial patterns in THg bioaccumulation differed among species. Some of this variation likely resulted from species-specific differences in home range size.

Crevalle jack, with the largest home range, grouped into two distinct regions: San Carlos Bay and the Ten Thousand Islands being significantly different.

Gray snapper, with a smaller home range, showed separation among four different areas.

Bivalves, either sessile or with very limited range, exhibited the greatest spatial variability. There were clear spatial differences within all regions except Estero Bay where no difference was found between sites. Some overlap between regions existed - higher concentrations in the Ten Thousand Islands were also found in Naples Bay and in one site from Estero Bay. Temporal patterns were also evident, perhaps relating to the amount of rainfall or flow from tributaries (2007 was a dry year while 2008 was wet). In general, Calico scallops collected offshore contained less THg than oysters collected from estuaries. Although species-related differences in bioaccumulation cannot be ruled out as a driver for this spatial pattern, similarities in THg levels in co-located Bay scallops and oysters suggests the observed pattern may reflect less mercury availability offshore.

Finally, both finfish and oysters showed a north-south gradient with higher THg concentrations in biota collected further south in Naples Bay and the Ten Thousand Islands.

Conclusion:

Methylmercury bioaccumulation was shown to be spatially highly variable. Consideration of home range size of sentinel species is important when designing a biomonitoring program. Species with large home ranges, such as jacks, are better biomonitors on a regional scale while oysters are better for locating fine scale spatial patterns or "hot spots". The assumptions made during the design of the CERP monitoring plan regarding use of gray snappers and jacks to track mercury bioaccumulation at different spatial scales appear valid.

References:

Brumbaugh, W.G., Krabbenhoft, D.P., Helsel, D.R., Wiener, J.G., and Echols, K.R., 2001, A National Pilot Study of Mercury Contamination of Aquatic Ecosystems Along Multiple Gradients: Bioaccumulation in Fish, USGS/BRD/BSR-2001-0009, iii + 25 pp.

Evans, D.W., NOAA, Personal communication.

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