Native Natural Enemies: Variation Among Regions and Habitats

Rebeccah A. Waterworth and Paula M. Shrewsbury Department of Entomology University of Maryland





This material is based upon work that is supported by the National Institute of Food and Agriculture, U.S. Department of Agriculture, Specialty Crop Research Initiative under award number 2016-51181-25409.

Brown Marmorated Stink Bug (BMSB)

- Polyphagous pest
- Highly mobile
- Found in many managed and nonmanaged habitats
- Sustainable pest management is needed: Biological control



Biological Control Agents Insects that attack BMSB eggs Parasitoids Predators



Project Objective

Regional complexes and habitat differences: Determine the impact of native natural enemies

Maximize impacts of natural enemies across agroecosystems



*States within regions that are part of this objective



Project Methods



Sentinel BMSB egg mass:

- <u>Fresh</u>: <24 hr after being laid
- Frozen: held at -80°C for less than 6 wk

Naturally-laid BMSB egg masses

Sentinel egg mass of other species



In the field:

- Egg mass pinned to the underside of a host leaf
- Remain in the field for ~3 days

Project Methods



In the lab:

- Storage
- Parasitoid collection and curation
- Egg mass dissections

Curated parasitoid



From Lara et al. 2016, Photo: S. Triapitsyn

Data Summary Contributing states to this dataset



Fail Intel Page Loyot Tormals Data Rever Vice O Talme what you wonth dode. Fail Bit Dia Dia Rever Vice O Talme what you wonth dode. Fail Bit Dia Dia Rever Second Dia Dia <thdia< th=""> Dia Dia</thdia<>		<u>ه.</u> ا	🖆 ÷							SCRI	_BMSB_natu	ral enemy	y datasheet_	revised 12Dec - Ex	kcel								1	囨
Aral Io Arad Io I	File	Home	Insert Pag	e Layout Formul	as Data F	leview View	Q Tell me what yo	u want to do																
Parts Bit I If I	-	K Cut	Arial	+ 10 - A	A* A* = = =	- 多- 昏wi	ap Text	eneral	*	₽		Norn	nal	Bad	Good	Ň	leutral	Calcul	ation		×	X AutoSum	· AT	p
Cliphod R Algend Algend Number State State State Clipho	Paste	Format	Painter B I L	1 - 🖽 - 1 💩 -	<u></u> ▲· ≡ ≡ =		erge & Center 👻	\$ * % *	00. 0.⇒ 0.€ 00.	Condition Formatting	al Formata g * Table *	s Chier	ck Cell	Explanatory T.	Input	L	inked Cell	Note	Ŧ	Insert Dele	ete Format	Clear *	Sort & Fir Filter + Sel	id 8 lect
A2 F G H J K L M N O P Q R S T U V V 1 bb/P:	3	lipboard	F24	Font	15	Alignment	15	Number	15						Styles					Cel	lls	E	diting	
A B C D E F G H I J K L M N O P Q R S T U V W 1 Lob/Pt: - </td <td>A2</td> <td></td> <td></td> <td>* 1</td> <td>fx f</td> <td></td>	A2			* 1	fx f																			
1 Lab (P): Parasitol s p: Parasitol s p: <	4	в	C	D	E	F	G	н	1.1	1	К	L	M	1 N	0	P	Q	R	s	Ť	U	v	w	1
2 xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	1 Lat	/PI:					1								1		Para	sitoid specie	s (ranked by f	requency/abur	ndance)			T
Sampling Date Interval Habitat Category Habitat Type Sampling approach stink bug species # of egg masses min max mean ID Count	2	1					1	1 1 1 1 1	% para	asitism by	emergence	% p;	arasitism b	y egg mortality	Parasitoid s	p1	Parasito	id sp 2	Parasito	id sp 3	Paras	itoid sp 4		1
4 MO 201 3-9/une orests wooded edge Sentine Irosen Halvomorpha haiys 11 Image: Model edge Image: Model edge <thimage: e<="" model="" td=""><td>3 Stat</td><td>e Year</td><td>Sampling Date Interval</td><td>Habitat Category</td><td>Habitat Type</td><td>Sampling approach</td><td>stink bug specie</td><td># of egg masses</td><td>min</td><td>max</td><td>mean</td><td>min</td><td>max</td><td>mean</td><td>ID</td><td>Count</td><td>ID</td><td>Count</td><td>ID</td><td>Count</td><td>ID</td><td>Count</td><td>other species (pooled)</td><td></td></thimage:>	3 Stat	e Year	Sampling Date Interval	Habitat Category	Habitat Type	Sampling approach	stink bug specie	# of egg masses	min	max	mean	min	max	mean	ID	Count	ID	Count	ID	Count	ID	Count	other species (pooled)	
5 MO 201 9-June orests woode doge Sentine_resh Halyomorpha halys 6 6 MD 201 9-June orchard apple Sentine_resh Halyomorpha halys 6 O	4 MD	201	1 6-9June	orests	wooded edge	Sentinel frozen	Halyomorpha haly	s 1	1			-											de concert	Ť
6 MD 201 3-9June inchard apple Sentine_fresh Halyomorpha halys 6	5 MD	201	5-9June	orests	wooded edge	Sentinel_fresh	Halyomorpha haly	s 1	8							1					-		1	T
7 MD 2013 3-9June Drchard papel Sentinel_frozen Halyomorpha halys 4 Image: Constraint of the sentine sen	6 MD	201	5-9June	Orchard	apple	Sentinel_fresh	Halyomorpha haly	S	6															T
8 MD 2013 3-9.June Drchard peach Sentinel_fresh Halyomorpha halys 6 Image: Control in the contr	7 MD	201	1 8-9June	Drchard	apple	Sentinel_frozen	Halyomorpha haly	S	4			-												T
9 MO 2013 3-June Orchard peach Sentinel frozen Halyomorpha halys 4	8 MD	201	17 6-9June	Orchard	peach	Sentinel_fresh	Halyomorpha haly	S	6												-			
00 MD 2017 3-9June Dmamentals nurseries Sentinel_fresh Halyomorpha halys 3	9 MD	201	17 6-9June	Orchard	peach	Sentinel_frozen	Halyomorpha haly	S	4			-				1 1								1.1
11 MD 2013 9-9.June Dmamentals nurseries Sentinel_froze Halyomorpha halys 2	IO MD	201	5-9June	Ornamentals	nurseries	Sentinel_fresh	Halyomorpha haly	S	3			- 1												
12 MD 201 20-23.June orests woode dege Sentinel_fresh Halyomorpha halys 28 TBO Image: Constraint of the constraint o	11 MD	201	17 6-9June	Ornamentals	nurseries	Sentinel_frozen	Halyomorpha haly	S	2	3	3	-				1								
13 MD 201 20-3 June orests wooded edge Sentinel_frozen Halyomorpha halys 6 TBD Image: Sentinel_frozen Image:	L2 MD	201	20-23June	orests	wooded edge	Sentinel_fresh	Halyomorpha haly	s 2	8 TBD			-				1			<u></u>	-	-			
1 1	13 MD	201	20-23June	orests	wooded edge	Sentinel_frozen	Halyomorpha haly	S	6 TBD												-		1	-
1 1	14														_		_					-	-	-
1 1	15																							_
1 1	16								-			-	-				_					_	-	+
1 1	1/	-	-					-	-	_		-	-							-	-	_		+
19 -	18		-						-	5 a.		-			-						-			-
	19		-		-				-	-	-	-	-					-				_		+
	20			-	-		-		-			-	-		_	-		-		-		_		+
	21		-					-	-	_	-	-			-	-	-	-		-			-	+
	22		-	-	-				+	-	-	-	-		-	-		-		-				+

Sampling period

B	5.	e - 1	-							SCRI	_BMSB_natur	al enemy	/ datasheet_	revised 12Dec - Ex	cel									囨
File		lome	Insert Pa	ge Layout Formula	as Data F	Review View	Q Tell me what you	i want to do											_					
-	Xa	ıt	Arial	+ 10 - A	* * = = =		ap Text G	eneral	*	Į,		Norm	nal	Bad	Good		Neutral	Calcul	ation		×	X AutoSum	· AT S	C
Paste		opy +	B I	<u>u</u> - 🖽 - 💩 - ,	A . = = =		erge & Center - \$	+ % +	€.0 .00 0.€ 00.	Condition	al Format as	Chec	k Cell	Explanatory T.	Input		Linked Cell	Note	* *	Insert Del	ete Format	fill ≠	Sort & Fin	d 8
	Clipbo	ard	Fa	Font	15	Alignment	6	Number	rg.	Formatting	g* Table*				Styles					Ce	ils.	E	Filter + Sele diting	:ct
A2				-	- fx																			
1	4	R	c	D	F	F	6	H	1 1	1.1	ĸ	1.1	M	N	0	p	0	R	s	Ť	IJ	v	W	
1 1	ah /PI	-				1	1		1	-		-					Par	asitoid snecie	s (ranked by f	requency/abu	ndance)	·		Ť
2	up n l.		5			-			% para	asitism by e	emergence	% pa	arasitism by	egg mortality	Parasitoid	sn 1	Parasit	add sn 2	Parasite	id sn 3	Paras	itoid sp 4	1	+
3 9	tate	Vear	Sampling Dat Interval	Habitat Category	Habitat Type	Sampling approach	stink bug species	# of egg masses	min	max	mean	min	max	mean		Count	ID	Count	ID	Count	ID	Count	other species (pooled)	Ī,
4 M	D	2017	6-9June	Forests	wooded edge	Sentinel frozen	Halvomorpha halvs	1	1	max	mean	1	Index	theat	10	Count	10	oount	10	oount	i.c	oount	(pooled)	Ť
5 M	D	2017	6-9June	Forests	wooded edge	Sentinel fresh	Halyomorpha halys	18	3												-			t
6 M	D	2017	6-9June	Orchard	apple	Sentinel_fresh	Halyomorpha halys	5 (3															T
7 M	D	2017	6-9June	Orchard	apple	Sentinel_frozen	Halyomorpha halys	3 4	4															T
8 M	D	2017	6-9June	Orchard	peach	Sentinel_fresh	Halyomorpha halys	5 (6															T
9 M	D	2017	6-9June	Orchard	peach	Sentinel_frozen	Halyomorpha halys	3 4	4												-		1	
LO M	D	2017	6-9June	Ornamentals	nurseries	Sentinel_fresh	Halyomorpha halys	3 3	3															
11 M	D	2017	6-9June	Ornamentals	nurseries	Sentinel_frozen	Halyomorpha halys	5 2	2		1						3		-	-			-	1
12 M	D	2017	20-23June	Forests	wooded edge	Sentinel_fresh	Halyomorpha halys	5 28	3 TBD								-							+
13 M	D	2017	20-23June	Forests	wooded edge	Sentinel_frozen	Halyomorpha halys	3 1	5 TBD			-	-			-							-	+
4		_	-					-	-	_	-	-	-		_	-	1	-		-		_		+
16						-		-			-	-	-			-	-		-	-				+
17		-							-			-	-			-	-	-		-				+
8	_	-		-	-				-			-				-	1			_	-	_		+
19		-	5	-	-	1	-				1	1		-		-	-	-				_	-	+
20																								t
21									-												15			T
22										-		0					1							T
10												1				C-1 1								T

Habitat Category:

- 1. Forests
- 2. Orchards
- 3. Ornamentals
- 4. Field/vegetable crops
- 5. Semi-natural
- 6. Mixed-unspecified

Habitat Type:

- 1. Wooded edges
- 2. Apple, peach, pear, hazelnut
- 3. Nurseries, urban landscapes
- 4. Corn, soybean, peppers
- 5. Campuses, parks, arboretum

File Paste										SCRI	BMSB_natu	al enemy	datasheet_	revised 12Dec - Ex	cel									R
Paste	Ho	me	Insert Page	Layout Formula	as Data R	leview View	Q Tell me what you	u want to do																
Paste	X Cut		Arial	+ 10 - A	* * = = =		ap Text G	eneral	*	,		Norm	al	Bad	Good		Veutral	Calcula	tion		× 🖬	∑ AutoSum	· AT	P
	* Forn	y nat Pai	nter B I U	- 🗉 - 🖄 • ,	▲ • ≡ ≡ =		erge & Center 👻 🖇	5 + % *	00. 0.→ 0.← 00.	Condition	al Format a	Chec	k Cell	Explanatory T	Input		Linked Cell	Note	Ŧ	Insert Dele	te Format	Clear *	Sort & F	ind 8 elect
	Clipboar	d	Fa.	Font.	15	Alignment	15	Number	15						Styles					Cell	ls	E	diting	
A2				* 5	√ fx																			
4	A	в	с	D	E.	F	G	н	1	1	К	L	M	N	0	P	Q	R	s	Ť	U	v	W	1
1 La	b /PI:				·			-							1		Para	sitoid species	s (ranked by f	requency/abun	idance)			-
2			2						o para	asitism by e	mergence	% pa	rasitism by	egg mortality	Parasitoi	d sp 1	Parasito	id sp 2	Parasito	id sp 3	Paras	itoid sp 4	Course or or	-
3 Sta	ate Ye	ar	Sampling Date Interval	Habitat Category	Habitat Type	Sampling approach	stink bug species	# of egg masses	m	max	mean	min	max	mean	ID	Count	ID	Count	ID	Count	ID	Count	other species (pooled)	,
4 MD)	2017	6-9June	Forests	wooded edge	Sentinel_frozen	Halyomorpha haly	s 11				1												
5 MD)	2017	6-9June	Forests	wooded edge	Sentinel_fresh	Halyomorpha haly	s 18	_												-			
6 MD)	2017	6-9June	Orchard	apple	Sentinel_fresh	Halyomorpha haly	s 6																
7 MD)	2017	6-9June	Orchard	apple	Sentinel_frozen	Halyomorpha haly:	s 4																
8 MD)	2017	6-9June	Orchard	peach	Sentinel_fresh	Halyomorpha haly:	s 6	-															
9 MD)	2017	6-9June	Orchard	peach	Sentinel_frozen	Halyomorpha haly	s 4					1											22.2
10 MD)	2017	6-9June	Ornamentals	nurseries	Sentinel_fresh	Halyomorpha haly	s 3														1		
11 MD)	2017	6-9June	Ornamentals	nurseries	Sentinel_frozen	Halyomorpha haly:	s 2		1	1	-									-			-
12 MD)	2017	20-23June	Forests	wooded edge	Sentinel_fresh	Halyomorpha haly	s 28	TID											-				
13 MD)	2017	20-23June	Forests	wooded edge	Sentinel_frozen	Halyomorpha haly	s 6	TID												_		1	_
14	_	-															1							_
15																								
16			-						-	-													-	_
17		_											-							-				-
18							4					-			-		-			-	-			-
19		_						-		_			_							-			-	_
20	-	-			-		-				-	-	-		-	-					-		-	-
21		_							-	-	-	-			-	-	-			-	-		-	-
22	-	-		-		-	-				-	-	-	-		-								-

Stink bug

species

Sampling approach

- **1. Sentinel fresh**
- 2. Sentinel frozen
- 3. Naturally laid

of egg masses used

E	15.	e - 1	1 ÷							SCRI_B	MSB_natur	al enemy da	tasheet_re	evised 12Dec - Exc	eli							团
File	e O	lome	Insert Page	e Layout Formul	as Data R	eview View	Q Tell me what y	ou want to do														
-	× Ci	ıt	Arial	+ 10 - A	A A = = =	- 8/- = Wr	ap Text	General				Normal		Bad	Good	Neutral	Calcu	lation	÷		∑ AutoSum	· AT D
Past	E E Co	ppy +	B I L	1 - 🖽 - 1 💩 -	A · = = =		erge & Center 👻	\$ + % *	€0 .00 0.€ 00.	Conditional	Format as	Check C	ell	Explanatory T.	Input	Linked Cell	Note	*	Insert	Delete Format	Fill +	Sort & Find &
	Clipbo	ard	Tá.	Font	15	Alignment	15	Number	rg.	Formatting *	Table *			S	tyles				7	Cells	E	Filter * Select diting
A2				+	√ fx																	
4	A	в	с	D	E	F	G	н	1.1	111	к	L	м	N	0 P	Q	R	S	Ť	U	v	W
1 1	ab /PI:			· · · · · · · · · · · · · · · · · · ·	·	1	1						S			Para	sitoid speci	es (ranked by f	requency/a	abundance)		
2	1	1	5 mm - 11 mm				1.1	1 1 1 1 1 1 1 1	% par	rasitism by em	ergence	% paras	itism by e	egg mortality	Parasitoid sp 1	Parasito	id sp 2	Parasito	id sp 3	Paras	itoid sp 4	
			Sampling Date Interval	Habitat Category	Habitat Type	Sampling approach	stink bug specie	# of egg masses														other species
N	1D	2017	6-9June	Forests	wooded edge	Sentinel_frozen	Halyomorpha ha	ys 1	1												-	n
5 1	ID.	2017	6 0 luno	Orchard	oppla	Continol frach	Halvemersha ha	100														
7 1		2017	6-9 June	Orchard	apple	Sentinel frozen	Halvomorpha ha	ys (1			-					-			-		
8 1	1D	2017	6-9 lune	Orchard	neach	Sentinel fresh	Halvomorpha ha	ve f				-							-			
A P	ND I	2017	6-9 June	Orchard	peach	Sentinel frozen	Halvomorpha ha	VS	1		-						-					
0 1	ID I	2017	6-9June	Ornamentals	nurseries	Sentinel fresh	Halvomorpha ha	VS		1									-			
1 1	1D	2017	6-9June	Ornamentals	nurseries	Sentinel frozen	Halvomorpha ha	VS	2				B			×.		-				
2 1	1D	2017	20-23June	Forests	wooded edge	Sentinel fresh	Halvomorpha ha	vs 28	TBD							1			1 1	1		
3 N	/D	2017	20-23June	Forests	wooded edge	Sentinel_frozen	Halyomorpha ha	ys (TBD				-						1000			1
4																						
5																		1				
6	-								1													-
.7		1																				
.8		-	-																-			
.9			S				1			- 1						- 1			-	- 1-	-	1
20	-										_		-									
!1		-					-		-				-				1					1
.2						4												1.1				

A survey (a row)- A unique combination of:

- 1. Research team
- 2. Sampling period
- 3. Habitat category and type
- 4. Sampling approach
- 5. Stink bug species

F	3 5	• e - j	- =							SCR	_BMSB_natu	ral enem	y datashee	t_revised 12Dec - Ex	cel									困
F	ile	Home	Insert Page	Layout Formu	las Data R	leview View	Q Tell me what yo	u want to do																
4	*	Tut	Arial	+ 10 - /	A* A* = = =	- ⊗- ₽w	rap Text	General	*			Norr	mal	Bad	Good		Neutral	Calcul	ation		×	∑ AutoSum	· AT	p
Pa	te te	ormat Pa	inter B I U	- 🗄 - 1 💆 -	A · = = =	■ <u>=</u> = = = = = = = = = = = = = = = = = =	erge & Center 👻	\$ + % +	€.0 .00 0.€ 00.	Condition	nal Formata	es Cher	ck Cell	Explanatory T	Input		Linked Cell	Note		Insert Del	ete Format	l Fill +	Sort & Fit	nd 8
	Clipb	oard	1 5.	Font	15	Alignment	15	Number	- a	- stringtin	g inere				Styles					Ce	lls	Er	diting	
A2					√ fx																			
4	A	в	с	D	E	F	G	H	1.1	J	к	L	1	N N	0	P	Q	R	s	Ť	U	v	w	1
1	Lab /P	:			· ·		1										Pa	arasitoid specie	s (ranked by f	requency/abu	ndance)			
21		1	3				1.		% par	asitism by	emergence	% p	arasitism	by egg mortality	Parasitoi	d sp 1	Paras	toid sp 2	Parasito	id sp 3	Paras	itoid sp 4		-
3	State	Year	Sampling Date Interval	Habitat Category	Habitat Type	Sampling approach	stink bug specie	s # of eg masse	min	max	mean	min	max	mean	ID	Count	ID	Count	ID	Count	ID	Count	other species (pooled)	
4	MD	2017	6-9June	Forests	wooded edge	Sentinel frozen	Halvomorpha hal	/S	1			-	100000										ALCONT A	1
5	MD	2017	6-9June	Forests	wooded edge	Sentinel fresh	Halvomorpha hal	/S	8			-				-								-
6	MD	2017	6-9June	Orchard	apple	Sentinel fresh	Halvomorpha hal	/S	6															-
7	MD	2017	6-9June	Orchard	apple	Sentinel frozen	Halyomorpha hal	/S	4						-		1							
8	MD	2017	6-9June	Orchard	peach	Sentinel_fresh	Halyomorpha hal	/S	6															
9	MD	2017	6-9June	Orchard	peach	Sentinel_frozen	Halyomorpha hal	/S	4			-					5							
10	MD	2017	6-9June	Ornamentals	nurseries	Sentinel_fresh	Halyomorpha hal	/S	3		-													
11	MD	2017	6-9June	Ornamentals	nurseries	Sentinel_frozen	Halyomorpha hal	/S	2		- 3						8		-					
12	MD	2017	20-23June	Forests	wooded edge	Sentinel_fresh	Halyomorpha hal	/S	BTBD			-	1.1								1			
13	MD	2017	20-23June	Forests	wooded edge	Sentinel_frozen	Halyomorpha hal	/S	6 TBD														1	
14											-						1							
15																	1.							
16																							-	_
17																	2			-	-			-
18			-												-	_	1							-
19		-						_	-		-	-	_			-				_			4	-
20		-	-									-				-					-			+
21		1		-				-			_	-			5		-			-	-			- 1
22	_	-	-				-	-	-		_	-				-		_		-				_
15									1			11	1										1	_

Parasitoids

% parasitism by emergence (Wasps emerged from stink bug eggs) % partial parasitoid development (Unhatched eggs were dissected and evaluated for signs of parasitism)

6	15	• • • •	= =							SCRI	BMSB_natur	al enemy	datasheet_re	vised 12Dec - Ex	cel									囨
Fil	e	Home	Insert Page	e Layout Formul	as Data R	leview View	Q Tell me what you	i want to do																
4	X	Cut	Arial	+ 10 - A	A* A* = = =	- ⊗- ₽w	ap Text G	eneral	*	₽		Norma	al	Bad	Good		Neutral	Calculat	ion			Σ AutoSum	· AT	ρ
Past	€ * F	opy +	inter B I L	1 - 🖽 - 1 💩 -	<u>∧</u> , ≡ ≡ =		erge & Center 👻 💲	- % -	00. 0. * 0.€ 00.	Condition	al Format as	Check	Cell	Explanatory T	Input		Linked Cell	Note	Ť	Insert Delet	e Format	Clear *	Sort & Fi Filter * Se	nd 8 lect
	Clipb	oard	T _M	Font	15	Alignment	15	Number	15						Styles					Cells		Er	diting	
A2				· E	- fx																			
1	A	в	C	D	F	F	G	H	1 1	1.1	K	L E	M	N	0	р	0	R	s	Ť	U	v	Ŵ	
1 1	ab /P		-		-	1	-		1	-		-									-			
21		i	1		-		-		% para	asitism by e	mergence	% par	asitism by e	on mortality	Parasitoid	Isn 1	Parasito	id sn 2	Parasito	id sn 3	Paras	itoid sp 4		-
3	State	Year	Sampling Date Interval	Habitat Category	Habitat Type	Sampling approach	stink bug species	# of egg masses	min	max	mean	min	max	mean	ID	Count	ID	Count	ID	Count	ID	Count	other species (pooled)	
4 1	/D	2017	6-9June	Forests	wooded edge	Sentinel_frozen	Halyomorpha haly	11	1															T
5 1	4D	2017	6-9June	Forests	wooded edge	Sentinel_fresh	Halyomorpha haly	18	3				1								_			T
6 1	/D	2017	6-9June	Orchard	apple	Sentinel_fresh	Halyomorpha haly	s 6	5					_			1							-
7 1	٨D	2017	6-9June	Orchard	apple	Sentinel_frozen	Halyomorpha haly:	6 4	4				-											
8 1	ND .	2017	6-9June	Orchard	peach	Sentinel_fresh	Halyomorpha haly:	6 6	3		1													1
9 1	/D	2017	6-9June	Orchard	peach	Sentinel_frozen	Halyomorpha haly:	6 2	4				2											12.0
10	ID	2017	6-9June	Ornamentals	nurseries	Sentinel_fresh	Halyomorpha haly	3	3				1			-	Ĵ.							-
11 1	//D	2017	6-9June	Ornamentals	nurseries	Sentinel_frozen	Halyomorpha haly:	5 2	2		2		1				3	-		-				
12	/D	2017	20-23June	Forests	wooded edge	Sentinel_fresh	Halyomorpha haly	28	B TBD				1							2				1
13	٨D	2017	20-23June	Forests	wooded edge	Sentinel_frozen	Halyomorpha haly	6	3 TBD				1											
14														-									-	
15																	1							
16											-	1											-	_
17	_	1	-					1			-	-		_	_				-		_			1
18	-		2									D	00				-		-		-			-
19	_		2						1 Sec		-	$\mathbf{\Gamma}$								4				- 1
20			1																			-		-
21		1	1						-		1	-		_	2	-							2	_
22			2											_								_		_
23									1			1	1											

<u>Parasitoids</u>

Emerged parasitoid species Most prevalent prevalent

- A	No	rmal	Bad		Good	Ner	utral	0	alculation			
mata	as Ch	eck Cell	Explana	tory T	Input	Lin	ked Cell	1	lote	Ŧ	Insert [Delete Format
ibie *				St	yles							Cells
	х	Y	Z	AA	AD	AC	AD	AE	AF	AG	AH	Al
	% pre	dation - co	mplete chew	% pre	Pre edation - in	complete chew	nige Sy % p	ndromes	- stylet suck	% pre	edation -	punctured suc
		0.1				1.0						
n	nin	max	mean	min	max	mean	min	max	mean	min	max	mean
+	-											
	-	-								-		
							-					
								_				

Predators

Four egg feeding syndromes (described in Morrison et al. 2016):

- 1. Complete chew
- 2. Incomplete chew
- 3. Stylet suck
- 4. Punctured suck





Rachel Suits

Walgenbach Lab

Prevalence of parasitoid species by habitat category



Prevalence of parasitoid species by region



Parasitism and Predation Impacts on Eggs



- Surveys with any *Tr.* japonicus were excluded
- Parasitoid emergence and partial parasitoid development were low overall
- Predation by complete chewing of fresh egg masses was low
- Predation was higher on frozen egg masses

Preliminary Results summarized by Waterworth and Shrewsbury, UMD 2017

Parasitism Impacts on Eggs by Habitat Category



- % emerged parasitism of native species
- Low levels of parasitism across habitats
- Need more surveys

 included to see how
 these data change

*Fresh and frozen sentinel egg masses combined



Preliminary Results summarized by Waterworth and Shrewsbury, UMD 2017 *Fresh and frozen sentinel egg masses combined

Conclusions

- Preliminary results from the 2017 season support certain parasitoid species are more prevalent in specific habitats
- Natural enemies were heavily surveyed in the mid-Atlantic region
- With fresh sentinel egg masses, there was low overall parasitoid emergence, partial parasitoid development, and predation by native species
- Need to incorporate additional 2017 data and samples over multiple years to elucidate more robust patterns

Acknowledgements

Delaware	Kim Hoelmer, Kathy Tatman
Kentucky	Ricardo Bessin, Lauren Fann
New York	Peter Jentsch
North Carolina	Jim Walgenbach, Emily Ogburn
Oregon	Nik Wiman, Heather Andrews, David Lowenstein
Pennsylvania	Greg Krawczyk
Utah	Diane Alston, Cody Holthouse, Zach Schumm
Virginia	Chris Bergh, Nicole Quinn
Washington State	Betsy Beers, Joshua Milne