

Supplementary Information to the article:

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Title: Feeding ecology and reproductive success of the Little Bittern *Ixobrychus minutus* in differently managed pond habitats

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Table S1 Prey composition of Little Bittern based on 1356 prey items from 78 broods. N – number of identified prey items; %N – percentage contribution to diet by numbers; %M – percentage contribution to diet by biomass; %F – percentage of occurrence in broods; L – larvae (for insects); I – imagines (for insects); T – sum of larvae and imagines (for insects) or individuals (for invertebrates other than insects)

CLASS	ORDER	FAMILY	GENUS or SPECIES	N	%N	%M	%F
ACTINOPTERYGII	CYPRINIFORMES	Cyprinidae	<i>Pseudorasbora parva</i>	373	27.51	11.87	61.54
			<i>Carassius gibelio</i>	243	17.92	35.39	55.13
			<i>Cyprinus carpio</i>	133	9.81	27.01	42.31
			<i>Leucaspis delineatus</i>	103	7.6	1.79	15.38
			<i>Rutilus rutilus</i>	7	0.52	3.01	7.69
			<i>Tinca tinca</i>	10	0.74	0.28	3.85
	PERCIFORMES	Percidae	<i>Perca fluviatilis</i>	32	2.36	3.4	10.26
	ESOCIFORMES	Esocidae	<i>Esox lucius</i>	3	0.22	0.99	1.28
	SILURIFORMES	Siluridae	<i>Silurus glanis</i>	1	0.07	0.06	1.28
	ACTINOPTERYGII TOTAL			905	66.74	83.8	88.46
AMPHIBIA	ANURA	Ranidae	<i>Pelophylax</i> sp.	98	7.23	10.67	51.28
		Pelobatidae	<i>Pelobates fuscus</i>	12	0.88	0.89	10.26
		Discoglossidae	<i>Bombina bombina</i>	19	1.4	0.35	6.41
	AMPHIBIA TOTAL			129	9.51	11.91	57.69
MAMMALIA	RODENTIA	Muridae	<i>Apodemus agrarius</i>	1	0.07	0.41	1.28
	MAMMALIA TOTAL			1	0.07	0.41	1.28

INSECTA

COLEOPTERA

		L	I	T	L	I	T	L	I	T	L	I	T
Chrysomelidae	Chrysomelidae sp.	0	1	1	0	0.07	0.07	0	<0.01	<0.01	0	1.28	1.28
	total	0	1	1	0	0.07	0.07	0	<0.01	<0.01	0	1.28	1.28
	<i>Tanysphyrus lemnae</i>	0	1	1	0	0.07	0.07	0	<0.01	<0.01	0	1.28	1.28
Curculionidae	Curculionidae sp.	0	1	1	0	0.07	0.07	0	<0.01	<0.01	0	1.28	1.28
	total	0	2	2	0	0.15	0.15	0	<0.01	<0.01	0	2.56	2.56
	<i>Coccinella septempunctata</i>	0	1	1	0	0.07	0.07	0	<0.01	<0.01	0	1.28	1.28
Coccinellidae	<i>Harmonia axyridis</i>	0	1	1	0	0.07	0.07	0	<0.01	<0.01	0	1.28	1.28
	total	0	2	2	0	0.15	0.15	0	<0.01	<0.01	0	1.28	1.28
	<i>Glischrochilus quadripunctatus</i>	0	1	1	0	0.07	0.07	0	<0.01	<0.01	0	1.28	1.28
Nitidulidae	total	0	1	1	0	0.07	0.07	0	<0.01	<0.01	0	1.28	1.28
	<i>Berosus</i> sp.	0	1	1	0	0.07	0.07	0	<0.01	<0.01	0	1.28	1.28
	<i>Hydrobius fuscipes</i>	0	1	1	0	0.07	0.07	0	<0.01	<0.01	0	1.28	1.28
	<i>Cercyon marinus</i>	0	2	2	0	0.15	0.15	0	<0.01	<0.01	0	2.56	2.56
	<i>Cercyon</i> sp.	0	1	1	0	0.07	0.07	0	<0.01	<0.01	0	1.28	1.28
Hydrophilidae	<i>Anacaena</i> sp.	0	1	1	0	0.07	0.07	0	<0.01	<0.01	0	1.28	1.28
	<i>Enochrus</i> sp.	0	4	4	0	0.29	0.29	0	<0.01	<0.01	0	5.13	5.13
	<i>Hydrochara caraboides</i>	2	0	2	0.15	0	0.15	<0.01	0	<0.01	2.56	0	2.56
	Hydrophilidae sp.	0	1	1	0	0.07	0.07	0	<0.01	<0.01	0	1.28	1.28
	total	2	11	13	0.15	0.81	0.96	<0.01	<0.01	0.01	2.56	14.1	16.67
	<i>Dryops</i> sp.	1	0	1	0.07	0	0.07	<0.01	0	<0.01	1.28	0	1.28
Dryopidae	total	1	0	1	0.07	0	0.07	0	0	0	1.28	0	1.28
	<i>Haliphus flavicollis</i>	0	2	2	0	0.15	0.15	0	<0.01	<0.01	0	2.56	2.56
Haliplidae	total	0	2	2	0	0.15	0.15	0	<0.01	<0.01	0	2.56	2.56
	<i>Rhantus latitans</i>	0	1	1	0	0.07	0.07	0	<0.01	0	0	1.28	1.28
	<i>Rhantus</i> sp.	0	1	1	0	0.07	0.07	0	<0.01	0	0	1.28	1.28
	<i>Hydroporus</i> sp.	8	0	8	0.59	0	0.59	<0.01	0	0	1.28	0	1.28
	<i>Graphoderus cinereus</i>	9	0	9	0.66	0	0.66	0.02	0	0.02	8.97	0	8.97
	<i>Graphoderus austriacus</i>	6	0	6	0.44	0	0.44	0.01	0	0.01	6.41	0	6.41
Dytiscidae	<i>Graphoderus</i> sp.	1	0	1	0.07	0	0.07	<0.01	0	0	1.28	0	1.28
	<i>Cybister lateralimarginalis</i>	11	0	11	0.81	0	0.81	0.44	0	0.44	8.97	0	8.97
	<i>Dytiscus marginalis</i>	1	0	1	0.07	0	0.07	0.03	0	0.03	1.28	0	1.28
	<i>Dytiscus dimidiatus</i>	2	0	2	0.15	0	0.15	0.06	0	0.06	2.56	0	2.56
	<i>Dytiscus circumcinctus</i>	1	0	1	0.07	0	0.07	0.01	0	0.01	1.28	0	1.28
	<i>Dytiscus</i> sp.	4	0	4	0.29	0	0.29	0.12	0	0.12	3.85	0	3.85

		Dytiscidae sp.	33	1	34	2.43	0.07	2.51	0.8	0.01	0.8	28.21	1.28	29.49	
		total	76	3	79	5.6	0.22	5.83	1.5	0.01	1.51	44.87	3.85	47.44	
		Coleoptera sp.	0	10	10	0	0.74	0.74	0	<0.01	<0.01	0	10.26	10.26	
		COLEOPTERA TOTAL	79	32	111	5.83	2.36	8.19	1.5	0.02	1.52	46.15	32.05	58.97	
HETEROPTERA	Aphrophoridae	Aphrophoridae sp.	0	2	2	0	0.15	0.15	0	<0.01	<0.01	0	2.56	2.56	
		total	0	2	2	0	0.15	0.15	0	<0.01	<0.01	0	2.56	2.56	
	Gerridae	Gerris sp.	0	2	2	0	0.15	0.15	0	<0.01	<0.01	0	2.56	2.56	
		total	0	2	2	0	0.15	0.15	0	<0.01	<0.01	0	2.56	2.56	
	Naucoridae	Ilyocoris cimicoides	12	14	26	0.88	1.03	1.92	0.04	0.11	0.15	10.26	10.26	16.67	
		total	12	14	26	0.88	1.03	1.92	0.04	0.11	0.15	10.26	10.26	16.67	
	Corixidae	Sigara sp.	0	3	3	0	0.22	0.22	0	<0.01	<0.01	0	3.85	3.85	
		Corixidae sp.	0	2	2	0	0.15	0.15	0	<0.01	<0.01	0	2.56	2.56	
		total	0	5	5	0	0.37	0.37	0	<0.01	<0.01	0	6.41	6.41	
	Notonectidae	Notonecta reuteri	0	2	2	0	0.15	0.15	0	0.01	0.01	0	2.56	2.56	
		Notonecta glauca	2	7	9	0.15	0.52	0.66	<0.01	0.05	0.05	2.56	7.69	8.97	
		Notonecta lutea	0	1	1	0	0.07	0.07	0	0.01	0.01	0	1.28	1.28	
		Notonecta sp.	29	13	42	2.14	0.96	3.1	0.05	0.08	0.13	21.79	15.38	32.05	
		total	31	23	54	2.29	1.7	3.98	0.05	0.15	0.2	23.08	25.64	38.46	
			HETEROPTERA TOTAL	43	46	89	3.17	3.39	6.56	0.09	0.26	0.35	30.77	35.9	48.72
	ODONATA	Calopterygidae	Calopteryx splendens	0	1	1	0	0.07	0.07	0	<0.01	<0.01	0	1.28	1.28
			total	0	1	1	0	0.07	0.07	0	<0.01	<0.01	0	1.28	1.28
		Coenagrionidae	Ischnura elegans	6	8	14	0.44	0.59	1.03	0.01	0.01	0.02	6.41	10.26	14.1
			Erythromma viridulum	2	1	3	0.15	0.07	0.22	<0.01	<0.01	<0.01	2.56	1.28	3.85
Coenagrion puella			0	1	1	0	0.07	0.07	0	<0.01	<0.01	0	1.28	1.28	
Coenagrionidae sp.			2	0	2	0.15	0	0.15	<0.01	0	<0.01	2.56	0	2.56	
total			10	10	20	0.74	0.74	1.47	0.02	0.01	0.03	8.97	10.26	16.67	
Libellulidae		Sympetrum sanguineum	1	0	1	0.07	0	0.07	<0.01	0	<0.01	1.28	0	1.28	
		Sympetrum flaveolum	1	0	1	0.07	0	0.07	<0.01	0	<0.01	1.28	0	1.28	
		Sympetrum sp.	0	1	1	0	0.07	0.07	0	<0.01	<0.01	0	1.28	1.28	
		total	2	1	3	0.15	0.07	0.22	0.01	<0.01	0.01	2.56	1.28	3.85	
Lestidae		Sympecma paedisca	6	1	7	0.44	0.07	0.52	0.02	<0.01	0.02	6.41	1.28	7.69	
		Chalcolestes viridis	2	0	2	0.15	0	0.15	0.01	0	0.01	2.56	0	2.56	
		Lestes sponsa	0	4	4	0	0.29	0.29	0	<0.01	<0.01	0	3.85	3.85	
		total	8	5	13	0.59	0.37	0.96	0.03	<0.01	0.03	8.97	5.13	14.1	
Aeshnidae		Anax imperator	3	0	3	0.22	0	0.22	0.19	0	0.19	3.85	0	3.85	

		<i>Aeshna affinis</i>	1	0	1	0.07	0	0.07	0.02	0	0.02	1.28	0	1.28
		<i>Aeshna cyanea</i>	4	0	4	0.29	0	0.29	0.15	0	0.15	3.85	0	3.85
		<i>Aeshna mixta</i>	17	0	17	1.25	0	1.25	0.33	0	0.33	8.97	0	8.97
		<i>Aeshna grandis</i>	2	0	2	0.15	0	0.15	0.08	0	0.08	2.56	0	2.56
		<i>Aeshna</i> sp.	25	0	25	1.84	0	1.84	0.48	0	0.48	24.36	0	24.36
		<i>Aeshnidae</i> indet.	17	0	17	1.25	0	1.25	0.55	0	0.55	15.38	0	15.38
		total	69	0	69	5.09	0	5.09	1.8	0	1.8	42.31	0	42.31
		Odonata sp.	2	1	3	0.15	0.07	0.22	0	0.01	0.02	2.56	1.28	2.56
		ODONATA TOTAL	91	18	109	6.71	1.33	8.04	1.86	0.03	1.89	47.44	15.38	52.56
	ORTHOPTERA	<i>Platycleis</i> sp.	0	1	1	0	0.07	0.07	0	0.01	0.01	0	1.28	1.28
		ORTHOPTERA TOTAL	0	1	1	0	0.07	0.07	0	0.01	0.01	0	1.28	1.28
		Lycosidae <i>Pardosa</i> sp.	—	—	2	—	—	0.15	—	—	0.01	—	—	2.56
		Pisauridae <i>Dolomedes fimbriatus</i>	—	—	3	—	—	0.22	—	—	0.09	—	—	2.56
		Argyronetidae <i>Argyroneta aquatica</i>	—	—	1	—	—	0.07	—	—	<0.01	—	—	1.28
		Araneae sp.	—	—	1	—	—	0.07	—	—	<0.01	—	—	1.28
		ARANEAE TOTAL	—	—	7	—	—	0.52	—	—	0.1	—	—	7.69
		Erpobdellidae <i>Erpobdella octoculata</i>	—	—	4	—	—	0.29	—	—	0.01	—	—	2.56
		ARHYNCHOBDELLIDA TOTAL	—	—	4	—	—	0.29	—	—	0.01	—	—	2.56

Study area: 4 fish pond complexes in eastern Poland, Garbów (51°21'N, 22°19'E), Samokłęski (51°26'N, 22°26'E), Czesławice (51°18'N, 22°16'E), Zagroda-Kozieniec (51°00'N, 23°21'E)

Estimation of prey body size:

Fish:

Body length (LT – *longitudo totalis*): measured directly in the field (not digested, identifiable items) or calculated on the basis of the length of diagnostic bones using bone-LT regressions available in the literature (Kovalev 1958; Horoszewicz 1960; Libois et al. 1987; Kloskowski et al. 2000; Beyer et al. 2006)

Body mass: calculated on the basis of LT-body mass regressions (Kovalev 1958; Horoszewicz 1960; Libois et al. 1987; Kloskowski et al. 2000; Rechulicz 2011)

Amphibians:

Body length (LC – *longitudo corporis*; used to estimate body mass of post-metamorphic individuals): measured directly in the field (identifiable items) or calculated (*Pelophylax* frogs) using self-developed regressions of the tibial length (hind legs and pelvic arches were commonly the only surviving body parts).

Body mass was estimated as follows: for post-metamorphs using regressions developed from individuals of known LC and mass; for *Pelophylax* frogs from measurements reported by Berger (1973); and for Fire-bellied Toad *Bombina bombina* from Kloskowski J. & Filipiuk M. (unpubl. data). As the rapid digestion of soft body parts prevents the exact determination of length and body mass, we adopted one size class for pre-metamorphic individuals: 1.5 g for *Pelophylax* frogs (see Semlitsch 1993) and 2 g for Common Spadefoot *Pelobates fuscus* (Kloskowski J. unpubl. data).

Unidentified fish and amphibians:

To estimate the length and body mass of unidentified Cyprinidae (1.5% of all prey items) or amphibians (0.5%), we used the regressions/values for the cyprinids/amphibians most numerous represented in a particular regurgitate.

Invertebrates:

Body length (used to obtain body mass in some taxa): measured directly in the laboratory (non-digested items) or obtained from comparisons with reference material or with data from the literature, e.g. Galewski & Tranda (1978), Wróblewski (1980), Galewski (1990 a,b; 1995), Klausnitzer (1996), Nilsson (1996, 1997), Galewski (1998) and Heidemann & Seidenbusch (2002).

Body mass: estimated as size classes based on measurements of individuals collected in the study area and on published data (Krebs & Avery 1985; Miserendino 2001; Hassall et al. 2008; Klecka & Boukal 2012, 2013; Edwards 1996; Smock 1980). For most taxa, dry mass was converted to fresh mass to make it compatible with vertebrate prey estimates; a universal factor for predatory aquatic animals was adopted, in which dry mass constitutes 0.23 of the fresh mass (Brey et al. 2010); exceptions: 0.32 for Odonata imagines (Krebs & Avery 1985; Bell 1990) and 0.4 for Coleoptera imagines (Sage 1982; Bell 1990).

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Table S2 ANOSIM R-statistic values for global analyses and for pairwise comparisons of numerical and biomass proportions of prey categories based on three main prey taxa (fish, amphibians and invertebrates; total N of prey individuals = 1350) between Little Bittern broods on ponds with different types of management. P-values are given in parentheses

Estimation of prey proportions	Global analysis	Pairwise comparisons			
		Management type*	Abandoned	Monoculture small-fish	Monoculture large-fish
Numerical	0.107 (0.003)	Monoculture small-fish	0.131 (0.005)	—	—
		Monoculture large-fish	0.016 (0.415)	−0.033 (0.599)	—
		Angling	0.064 (0.039)	0.219 (<0.001)	0.009 (0.428)
Biomass	−0.001 (0.456)	Monoculture small-fish	0.020 (0.185)	—	—
		Monoculture large-fish	−0.058 (0.605)	−0.080 (0.689)	—
		Angling	0.002 (0.347)	0.033 (0.145)	−0.098 (0.728)

* Small-fish ponds, N=20; large-fish ponds, N=6; abandoned ponds, N=21; angling ponds, N=26

Table S3 ANOSIM R-statistic values for global analyses and for pairwise comparisons of numerical and biomass proportions of prey categories (with fish and amphibians analysed at species level and invertebrates as a single category; total N of prey individuals = 1350) between Little Bittern broods on ponds with different types of management. P-values are given in parentheses

Estimation of prey proportions	Global analysis	Pairwise comparisons			
		Management type*	Abandoned	Monoculture small-fish	Monoculture large-fish
Numerical	0.262 (0.0001)	Monoculture small-fish	0.311 (<0.001)	—	—
		Monoculture large-fish	0.607 (<0.001)	0.237 (0.042)	—
		Angling	0.089 (0.015)	0.295 (<0.001)	0.456 (0.002)
Biomass	0.234 (0.0001)	Monoculture small-fish	0.428 (<0.001)	—	—
		Monoculture large-fish	0.553 (<0.001)	0.238 (0.055)	—
		Angling	−0.005 (0.487)	0.247 (<0.001)	0.352 (0.005)

*Sample sizes as in Table S2.

Table S4 Results of the GLMM relating the H' index of prey diversity in Little Bittern broods (N=73) to the time of season and pond management type. The number of visits during which regurgitates were obtained from each nest was entered into the analysis as a random factor. Sample sizes are shown in parentheses

Predictor	F	d.f.	p	Effect	SE
Brood hatching date (days)	0.10	1, 67.0	0.751	0.003	0.009
Pond type	1.43	3, 67.1	0.241		
Monoculture small-fish ponds (20)				0.000	0.000
Monoculture large-fish ponds (6)				−0.648	0.526
Abandoned ponds (21)				0.259	0.407
Angling ponds (26)				−0.322	0.367