Online supplement

Table 1. Example of extraction of paired effect sizes. The table shows invasion impact data extracted from Fig. 1b in Thomsen (2010). The mean *d* for Fig. 1b is 0.750. Similar data extractions and calculations were repeated for all presented data figures, tables, texts, that fulfil our study requirements (see method section). For this particular study the final single averaged *d* was 0.621 (the average of 6 *d* values extracted from Fig. 1b -1h), and this final "independent" effect size was used in the cumulative meta-analysis to contribute with 1 degree of freedom (out of 39 values for the abundance attribute test, see table 2 below).

Abundance	Depth	Control Mean	Control SD	N	Treatment Mean	Treatment SD	Treatment N	d	*d*
High	Deep	14.571	6.268	7	35.857	16.466	7	1.599	
Low	Deep	14.571	6.268	7	18.875	13.196	8	0.383	1.217
High	Shallow	16.667	6.377	6	34.571	36.304	7	0.613	
Low	Shallow	16.667	6.377	6	20.833	14.662	6	0.340	0.273
								mean *d* for Fig 1B =	0.750

Table 2. Aquatic experimental field-based invasion impact studies that fulfilled our six data requirements (see method section).

Study	Comparison: Invader Abundance (universal attribute)	Marine/Fresh	Plant/Animal	Feeding
(Kotta et al. 2006)	*Balanus improvisus* (crustacean)	Marine	Animal	Filter
(Byers 2000)	*Batillaria attramentaria* (snail)	Marine	Animal	Herbivore
(Davis et al. 1998)	*Carcinus maenas* (crab)	Marine	Animal	Carnivore
(Griffen and Byers 2009)	*Carcinus maenas* (crab)	Marine	Animal	Carnivore
(Lohrer and Whitlatch 2002b)	*Carcinus maenas* (crab)	Marine	Animal	Carnivore
(Hakenkamp et al. 2001)	*Corbula fluminea* (bivalve)	Freshwater	Animal	Filter
(Matsuzaki et al. 2009)	*Cyprinus carpio* (fish)	Freshwater	Animal	Carnivore
(Williams et al. 2002)	*Cyprinus carpio* (fish)	Freshwater	Animal	Carnivore
(Jack and Thorp 2000)	*Dreissena polymorpha* (bivalve)	Freshwater	Animal	Filter
(Horvath et al. 1999)	*Dreissena polymorpha* (bivalve)	Freshwater	Animal	Filter
(Mony et al. 2007)	*Egeria densa* (angiosperm)	Freshwater	Plant	Plant
(Mills et al. 2004)	*Gambusia affinis* (fish)	Freshwater	Animal	Carnivore
(Thomsen 2010)	*Gracilaria vermiculphylla* (algae)	Marine	Plant	Plant
(Griffen and Byers 2009)	*Hemigrapsus sanguineus* (crab)	Marine	Animal	Carnivore
(Lohrer and Whitlatch 2002b)	*Hemigrapsus sanguineus* (crab)	Marine	Animal	Carnivore
(Mony et al. 2007)	*Hydrilla verticillata* (angiosperm)	Freshwater	Plant	Plant
(Doyle et al. 2003)	*Hygrophila polysperma* (angiosperm)	Freshwater	Plant	Plant
(Lubchenco 1983)	*Littorina littorea* (snail)	Marine	Animal	Herbivore
(Brenchley and Carlton 1983)	*Littorina littorea* (snail)	Marine	Animal	Herbivore
(Altieri et al. 2009)	*Littorina littorea* (snail)	Marine	Animal	Herbivore
(Keller and Lake 2007)	*Misgurnus anguilicaudatus* (fish)	Freshwater	Animal	Carnivore
(Reusch and Williams 1998)	*Musculista senhousia* (bivalve)	Marine	Animal	Filter
(Valley and Newman 1998)	*Myriophyllum spicatum* (angiosperm)	Freshwater	Plant	Plant
(Lodge and Lorman 1987)	*Orconectes rusticus* (crayfish)	Freshwater	Animal	Carnivore
(Charlebois and Lamberti 1996)	*Orconectes rusticus* (crayfish)	Freshwater	Animal	Carnivore
(Stewart et al. 1998)	*Orconectes rusticus* (crayfish)	Freshwater	Animal	Carnivore
(Nystroem et al. 2001)	*Orconectes virilis* (crayfish)	Freshwater	Animal	Carnivore
(Chambers 1990)	*Orconectes virilis* (crayfish)	Freshwater	Animal	Carnivore

(Stenroth and Nystroem 2003)	*Pacifastacus leniusculus* (crayfish)	Freshwater	Animal	Carnivore
(Carlsson et al. 2004)	*Pomacea canaliculata* (snail)	Freshwater	Animal	Herbivore
(Fang et al. 2010)	*Pomacea canaliculata* (snail)	Freshwater	Animal	Herbivore
(Gherardi and Acquistapace 2007)	*Procambarus clarkii* (crayfish)	Freshwater	Animal	Carnivore
(Matsuzaki et al. 2009)	*Procambarus clarkii* (crayfish)	Freshwater	Animal	Carnivore
(Kiesecker et al. 2001)	*Rana catesbeiana* (amphibian)	Freshwater	Animal	Carnivore
(Ross et al. 2007)	*Sabella spallanzani*i (polychaete)	Marine	Animal	Filter
(Lang and Buschbaum 2010)	*Sargassum muticum* (algae)	Marine	Plant	Plant
(Ross et al. 2007)	*Styela clava* (tunicate)	Marine	Animal	Filter
(Byers 2005)	*Venerupis philippinarum* (bivalve)	Marine	Animal	Filter
(Airoldi 2000)	*Womersleyella setacea* (algae)	Marine	Plant	Plant

Study	**Comparison: Invader Identity (unique attribute)**	**Marine/Fresh**	**Plant/Animal**	**Feeding**
(Lohrer and Whitlatch 2002b)	*Carcinus maenas* vs. *Hemigrapsus sanguineus*	Mar vs. Mar	Ani vs. Ani	Car vs. Car
(Lohrer and Whitlatch 2002a)	*Carcinus maenas* vs. *Hemigrapsus sanguineus*	Mar vs. Mar	Ani vs. Ani	Car vs. Car
(Maezono et al. 2005)	*Lepomis macrochirus* vs. *Micropterus salmoides*	Fre vs. Fre	Ani vs. Ani	Car vs. Car
(Kimbro et al. 2009)	*Carcinus maenas* vs. *Urosalpinx cinerea*	Mar vs. Mar	Ani vs. Ani	Car vs. Car
(Levin et al. 2002)	*Codium fragile* vs. *Membranipora membranacea*	Mar vs. Mar	Pla vs. Ani	Pla vs Fil
(Johnson et al. 2009)	*Bellamya chinensis* vs. *Orconectes rusticus*	Fre vs. Fre	Ani vs. Ani	Her vs. Car
(Gamradt and Kats 1996)	*Gambusia affinis* vs. *Procambarus clarkii*	Fre vs. Fre	Ani vs. Ani	Car vs. Car
(Nystroem et al. 2001)	*Oncorhynchus mykiss* vs. *Pacifastacus leniusculus*	Fre vs. Fre	Ani vs. Ani	Car vs. Car
(Eastwood et al. 2007)	*Littorina littorea* vs. *Carcinus maenas*	Mar vs. Mar	Ani vs. Ani	Her vs. Car
(Matsuzaki et al. 2009)	*Cyprinus carpio* vs. *Procambarus clarkii*	Fre vs. Fre	Ani vs. Ani	Car vs. Car
(Ross et al. 2004)	*Asterias amurensis* vs. *Carcinus maenas*	Mar vs. Mar	Ani vs. Ani	Car vs. Car
(Griffen and Byers 2009)	*Carcinus maenas* vs. *Hemigrapsus sanguineus*	Mar vs. Mar	Ani vs. Ani	Car vs. Car
(Byrnes and Stachowicz 2009)	*Botrylloides violaceus* vs. *Ciona intestinalis* vs. *Dedemnum vexillum* vs. *Mytilus galloprovincialis* vs. *Watersipora subtorquata*	Mar vs. Mar	Ani vs. Ani	Fil vs. Fil
(Young et al. 2009)	*Oncorhynchus mykiss* vs. *Salmo salar*	Fre vs. Fre	Ani vs. Ani	Car vs. Car
(Ross et al. 2007)	*Sabella spallanzanii* vs. *Styela clava*	Mar vs. Mar	Ani vs. Ani	Fil vs. Fil

Table 3. Recommendations for data to report in impact studies. Quantitative synthesis of invasion impact and theoretical development could benefit tremendously if the listed recommendations are adapted for case-studies on invasion impact. Most recommendations (minus 3, 4 and 9 which are standard scientific requirements) come free-of-cost to investigators, editors, reviewers and readers, and can be presented in online appendixes to keep the publication short and precise. Points 1-3 are relevant specifically for invasion impact experiments whereas points 1-7 are general points of relevance for fundamental scientific enquiries.

1. Report when then invader was observed first time in the study region – as impact can change dramatically over time due to rapid adaptations and co-evolution.
2. Report whenever possible the origin of impacted resident organisms, as many residents may also be non-native species themselves. When impacts are reported above the species level it should be reported if impacted organisms (resident biota) contain other aliens.
3. Quantify and report abundances of the invader (dependent variable; at a minimum at the start and end of the experiments).
4. Replicate treatments and controls (also for proportional data; e.g. 'mortality') and avoid whenever possible pseudo-replication.
5. Report dispersal values and number of replicates with the associated mean values. If box plots are presented in the paper, then add means and SD information (or SE, CL) to online appendix.
6. Show non-significant results and non-pooled data, if not in the paper then in online appendix to avoid bias and facilitate future testings of impact-generalities. This is particularly relevant if species-level data are quantified, but results are pooled into higher taxonomic units.
7. Interpret results according to type of evidence presented and be cautions when extrapolate the findings (e.g., if inferring causality from mensurative experiments, when interpolating across systems, hierarchical levels; experimental artefacts).
8. Report as many standard experimental conditions as possible (e.g., plot sizes, date of experiment, cage designs, mesh-sizes, etc.).
9. For manipulative experiments; include manipulator/cage control (also for experiments conducted on sessile invaders).

Table 4. List of Aquatic experimental field-based invasion impact studies that fulfilled all six data requirements (see method section).

Airoldi L (2000) Effects of disturbance, life histories, and overgrowth on coexistence of algal crusts and turfs. Ecology 81: 798-814

Altieri A, Trussell G, Ewanchuck P, Bernatchez G (2009) Consumers control diversity and functioning of a natural marine ecosystem. PLoS Biology 4: e5291

Brenchley GA, Carlton JT (1983) Competitive displacement of native mud snails by introduced periwinkles in the New England intertidal zone. Biological Bulletin 165: 543-558

Byers J (2000) Competition between two estuarine snails: implications for invasions of exotic species. Ecology 81: 1225-1239

Byers JE (2005) Marine reserves enhance abundance but not competitive impacts of a harvested nonindigenous species. Ecology 86: 487-500

Byrnes JE, Stachowicz JJ (2009) Short and long term consequences of increases in exotic species richness on water filtration by marine invertebrates. Ecology Letters 12: 830-841

Carlsson NOL, Bronmark C, Hansson LA (2004) Invading herbivory: The golden apple snail alters ecosystem functioning in Asian wetlands. Ecology 85: 1575-1580

Chambers PA (1990) The impact of the crayfish Orconectes virilis on aquatic macrophytes. Freshwater Biology 24: 81-91

Charlebois PM, Lamberti GA (1996) Invading crayfish in a Michigan stream: direct and indirect effects on periphyton and macroinvertebrates. J. N. Am. Benthol. Soc. 15: 551-563

Davis RC, Short FT, Burdick DM (1998) Quantifying the effects of green crab damage to eelgrass transplants. Restoration Ecology 6: 297-302

Doyle RD, Francis M, Smart RM (2003) Interference competition between *Ludwigia repens* and *Hygrophila polysperma*: to morphologically similar aquatic plant species. Aquatic Botany 77: 223-234

Eastwood MM, Donahue MJ, Fowler AE (2007) Reconstructing past biological invasions: niche shifts in response to invasive predators and competitors. Biological Invasions 9: 397-407

Fang L, Wong PK, Lin L, Lan C, Qui HW (2010) Impact of invasive apple snails in Hong Kong on wetland macrophytes, nutrients, phytoplankton and filamentous algae. Freshwater Biology 55: 1191-1204

Gamradt SC, Kats LB (1996) Effect of introduced crayfish and mosquitofish on California newts. Conservation Biology 10: 1155-1162

Gherardi F, Acquistapace P (2007) Invasive crayfish in Europe: the impact of *Procambarus clarkii* on the littoral community of a Mediterranean lake. Freshwater Biology

Griffen BD, Byers JE (2009) Community impacts of two invasive crabs: the interactive roles of density, prey recruitment, and indirect effects. Biological Invasions 11: 927-940

Hakenkamp CC, Ribblett SG, Palmer MA, Swan CM, Reid JW, Goodison MR (2001) The impact of an introduced bivalve (*Corbicula fluminea*) on the benthos of a sandy stream. Freshwater Biology 46: 491-501

Horvath TG, Marin KM, Lamberti GA (1999) Effects of zebra mussels, *Dreissena polymorpha*, on macroinvertebrates in a Lake-outlet Stream. Am. Midl. Nat. 142: 340-347

Jack JD, Thorp JH (2000) Effects of the benthic suspension feeder *Dreissena polymorpha* on zooplankton in a large river. Freshwater Biology 44: 569-579

Johnson PTJ, Olden J, Solomon CT, Zanden MJV (2009) Interactions among invaders: community and ecosytem effects on mulitple invasive species in an experimental aquatic system. Oecologia 159

Keller RP, Lake PS (2007) Potential impacts of a recent and rapidly spreading colonizer of Australian freshwaters: oriental weatherloach (*Misgurnus anguillicaudatus*). Ecology of Freshwater Fish 16: 124-132

Kiesecker JM, Blaustein L, Miller CL (2001) Potential mechanisms underlying the displacement of native red-legged frogs by introduced bullfrogs. Ecology 82: 1964-1970

Kimbro DL, Grozholz ED, Baukus AJ, Nesbitt NJ, Travis NM, Attoe S, Coleman-Hulbert C (2009) Invasive species cause large-scale loss of native California oyster habitat by disrupting trophic cascades. Oecologia: 563-575

Kotta J, Kotta I, Simm M, Lankov A, Laurinson V, Pollumae HO (2006) Ecological concequences of biological invasions: three invertebrate case studies in the north-eastern Baltic Sea. Helgol. Mar. Res. 60: 106-112

Lang AC, Buschbaum C (2010) Facilitative effects of introduced Pacific oysters on native macroalgae are limited by a secondary invader, the seaweed *Sargassum muticum*. Journal of Sea Research 63: 119-128

Levin PS, Coyer JA, Petrik R, Good TP (2002) Community-wide effects of nonindigenous species on temperater rocky reefs. Ecology 83: 3182-3193

Lodge DM, Lorman JG (1987) Reductins in submersed macrophyte biomass and species richness by the crayfish *Orconectes rusticus*. Can. J. Fish. Aquat. Sci. 44: 591-597

Lohrer AM, Whitlatch RB (2002a) Interactions among aliens: apparent replacement of one exotic species by another. Ecology 83: 719-732

Lohrer AM, Whitlatch RB (2002b) Relative impacts of two exotic brachyuran species on blue mussel populations in Long Island Sound. Marine Ecology Progress Series 227: 135-144

Lubchenco J (1983) *Littorina* and *Fucus*: Effects of herbivores, substratum heterogeneity, and plant escapes during succession. Ecology 64: 1116-1123

Maezono Y, Kobayashi R, Kusahara M, Miyashita T (2005) Direct and indirect effects of exotic bass and bluegill on exotic and native organisms in farm ponds. Ecological Applications 15: 638-650

Matsuzaki SS, Usio N, Takamura N, Washitani I (2009) Contrasting impacts of invasive engineers on freshwater ecosystems: an experiment and meta-analysis. Oecologia 158: 673-686

Mills MD, Rader RB, Belk MC (2004) Complex interactions between native and invasive fish: the simultaneous effects of multiple negative interactions. Oecologia 141: 713-721

Mony C, Koschnick TJ, Haller WT, Muller S (2007) Competition between two invasive Hydrocharitaceae (*Hydrilla verticillata*) (L.f.) (Royle) and *Egeria densa* (Planch)) as influenced by sediment fertility and season. Aquatic Botany 86: 236-242

Nystroem P, Svennson O, Lardner B, Broenmark C, Graneli W (2001) The influence of multiple introduced predators on a littoral pond community. Ecology 82: 1023-1039

Reusch TBH, Williams SL (1998) Variable response of natie eelgrass *Zostera marina* to a non-indigenous bivalve *Musculista senhousia*. Oecologia 113: 428-441

Ross DJ, Johnson C, Hewitt CL, Ruiz GM (2004) Interaction and impacts of two introduced species in a soft-bottom marine assemblage in SE Tasmania. Marine Biology 144: 747-756

Ross DJ, Keough MJ, Longmore AR, Knott NA (2007) Impacts of two introduced suspension feeders in Port Phillip Bay, Australia. Marine Ecology Progress Series 340: 41-53

Stenroth P, Nystroem P (2003) Exotic crayfish in a brown water stream: effects on juvenile trout, invertebrates and algae. Freshwater Biology 48: 466-475

Stewart TW, Miner JG, Lowe RL (1998) An experimental analysis of crayfish (*Orconectes rusticus*) effects on a *Dreissena*-dominated benthic macroinvertebrate community in Western Lake Erie. Can. J. Fish. Aquat. Sci. 55: 1043-1050

Thomsen MS (2010) Experimental evidence for positive effects of invasive seaweed on native invertebrates via habitat-formation in a seagrass bed. Aquatic Invasions 5: 341–346

Valley RD, Newman RM (1998) Competitive interaction between euroasian watermilfoil and northern watermilfoil in experimental tanks. J. Aquat. Plant Manage. 36: 121-126

Williams AE, Moss B, Eaton J (2002) Fish induced macrophyte loss in shallow lakes: top-down and bottom-up processes in mesocosm experiments. Freshwater Biology 47: 2216-2232

Young KA, Stephenson J, Terreau A, Thailly AF, Gajardo G, de Leaniz CG (2009) The diversity of juvenile salmonids does not affect their competitive impact on a native galaxiid. Biological Invasions 11: 1955-1961