Table S1: General guidelines for detecting groups (or modules) in ecological systems. We note that: (1) the recommended approach is not necessarily the one commonly applied in the literature; (2) the referenced examples from ecological studies is merely a sample — many more studies exist; (3) there are other aims or research questions that will require modularity analysis and that are not mentioned here; (4) software only includes stand-alone packages (not scripts published for a particular study).

I want to detect...	**Examples of ecological studies**	**Recommended approach**	**Software**	**Methodological references**	**Possible with Infomap?**
Groups of species that interact more among themselves than with other species in the network	Olesen *et al.* (2007); Thébault & Fontaine (2010); Stouffer & Bascompte (2011); Peralta *et al.* (2017)	Maximizing density	**RNetcarto R package** (for unipartite undirected networks) **bipartite R package** (bipartite, weighted/ unweighted networks) **MODULAR** (bipartite unweighted networks) (Marquitti *et al.* (2014)) **Infomap**	Newman & Girvan (2004); Guimerà *et al.* (2007); Dormann & Strauss (2014); Beckett (2016); Software: (Dormann *et al.* (2009); Marquitti *et al.* (2014))	Yes, with an undirected flow model
Groups of species that tend to occur in the same patches	Fortuna *et al.* (2009); Thébault (2013); Edler *et al.* (2017)				
Modularity as a signature for assembly processes.	Maynard *et al.* (2018); He *et al.* (2018)				
Modular structure that may slow down perturbation spread across the network (disease spread, local invasion/extinction).	Stouffer & Bascompte (2011); Gilarranz *et al.* (2017); Sah *et al.* (2017); Griffin & Nunn (2011).	Flow	Infomap	Rosvall & Bergstrom (2008); Rosvall *et al.* (2010)	Yes
Groups of connected patches that facilitate dispersal or gene transfer.	Fletcher, Jr *et al.* (2013); Peterman *et al.* (2016)				
Groups of organisms with increased gene flow	Popa *et al.* (2011)				
Modules of species that strongly interact in time, space or across kinds of interactions	Pilosof *et al.* (2017, 2019); Timóteo *et al.* (2018)	Maximizing density / flow	**Infomap** with multilayer networks	Mucha *et al.* (2010); De Domenico *et al.* (2015)	

I want to detect...	**Examples of ecological studies**	**Recommended approach**	**Software**	**Methodological references**	**Possible with Infomap?**
Groups of species that interact in a similar way with other groups of species (ecological equivalence)	Baskerville *et al.* (2011); Ohlsson & Eklöf (2020)	Structural and Regular equivalence; SBM	**blockmodels R package** (Leger (2015))	(Luczkovich *et al.* (2003); Allesina & Pascual (2009)	No
Groups of species that possess unique roles in a network	Michalska-Smith *et al.* (2018)		**graph-tool** (https://graph-tool.skewed.de/) Peixoto (2014)	Peixoto (2014); Yen & Larremore (2020)	
Groups of species that interact similarly with other species across different kinds of interactions	Sander *et al.* (2015); Kéfi *et al.* (2016)		**blockmodels R package** with multiplex networks (Barbillon *et al.* (2015)		

References

Allesina, S. & Pascual, M. (2009) Food web models: a plea for groups. *Ecol. Lett.* **12**, 652–662.

Aslak, U., Rosvall, M. & Lehmann, S. (2018) Constrained information flows in temporal networks reveal intermittent communities. *Phys. Rev. E* **97**, 062312.

Barbillon, P., Donnet, S., Lazega, E. & Bar-Hen, A. (2015) Stochastic Block Models for Multiplex networks: an application to networks of researchers .

Baskerville, E.B., Dobson, A.P., Bedford, T., Allesina, S., Anderson, T.M. & Pascual, M. (2011) Spatial guilds in the serengeti food web revealed by a bayesian group model. *PLoS Comput. Biol.* **7**, e1002321.

Beckett, S.J. (2016) Improved community detection in weighted bipartite networks. *R Soc Open Sci* **3**, 140536.

Blöcker, C. & Rosvall, M. (2020) Mapping flows in bipartite networks .

Blondel, V.D., Guillaume, J.L., Lambiotte, R. & Lefebvre, E. (2008) Fast unfolding of communities in large networks. *J. Stat. Mech.* **2008**, P10008.

Bohlin, L., Edler, D., Lancichinetti, A. & Rosvall, M. (2014) Community detection and visualization of networks with the map equation framework. *Measuring Scholarly Impact*, pp. 3–34, Springer International Publishing.

Brin, S. & Page, L. (1998) The anatomy of a large-scale hypertextual web search engine. *Computer networks and ISDN systems* **30**, 107–117.

Brose, U., Pavao-Zuckerman, M., Eklöf, A., Bengtsson, J., Berg, M.P., Cousins, S.H., Mulder, C., Verhoef, H.A. & Wolters, V. (2005) Spatial aspects of food webs. *Food Web Symposium 2003, Giessen, Germany, 13-16 November 2003*, vol. 3, pp. 463–469, Elsevier.

Calatayud, J., Bernardo-Madrid, R., Neuman, M. & others (2019) Exploring the solution landscape enables more reliable network community detection. *arXiv preprint arXiv* .

Cirtwill, A.R. & Eklöf, A. (2018a) Feeding environment and other traits shape species' roles in marine food webs. *Ecol. Lett.* **21**, 875–884.

Cirtwill, A.R. & Eklöf, A. (2018b) Feeding environment and other traits shape species' roles in marine food webs. *Ecology letters* **21**, 875–884.

Danon, L., Díaz-Guilera, A., Duch, J. & Arenas, A. (2005) Comparing community structure identification. *J. Stat. Mech.* **2005**, P09008.

De Domenico, M., Lancichinetti, A., Arenas, A. & Rosvall, M. (2015) Identifying modular flows on multilayer networks reveals highly overlapping organization in interconnected systems. *Phys. Rev. X* **5**, 011027.

De Domenico, M., Solé-Ribalta, A., Cozzo, E., Kivelä, M., Moreno, Y., Porter, M.A., Gómez, S. & Arenas, A. (2013) Mathematical formulation of multilayer networks. *Phys. Rev. X* **3**, 041022.

Dormann, C.F., Fründ, J., Blüthgen, N. & Gruber, B. (2009) Indices, graphs and null models: analyzing bipartite ecological networks. *The Open Ecology Journal* **2**, 7–24.

Dormann, C.F. & Strauss, R. (2014) A method for detecting modules in quantitative bipartite networks. *Methods Ecol. Evol.* **5**, 90–98.

Edler, D., Bohlin, L. & Rosvall, M. (2017) Mapping higher-order network flows in memory and multilayer networks with infomap. *Algorithms* .

Eklöf, A., Jacob, U., Kopp, J., Bosch, J., Castro-Urgal, R., Chacoff, N.P., Dalsgaard, B., de Sassi, C., Galetti, M., Guimarães, P.R., Lomáscolo, S.B., Martín González, A.M., Pizo, M.A., Rader, R., Rodrigo, A., Tylianakis, J.M., Vázquez, D.P. & Allesina, S. (2013) The dimensionality of ecological networks. *Ecol. Lett.* **16**, 577–583.

Emmons, S. & Mucha, P.J. (2019) Map equation with metadata: Varying the role of attributes in community detection. *Phys Rev E* **100**, 022301.

Fletcher, Jr, R.J., Revell, A., Reichert, B.E., Kitchens, W.M., Dixon, J.D. & Austin, J.D. (2013) Network modularity reveals critical scales for connectivity in ecology and evolution. *Nat. Commun.* **4**, 2572.

Fortuna, M.A., Popa-Lisseanu, A.G., Ibáñez, C. & Bascompte, J. (2009) The roosting spatial network of a bird-predator bat. *Ecology* **90**, 934–944.

Fortuna, M.A., Stouffer, D.B., Olesen, J.M., Jordano, P., Mouillot, D., Krasnov, B.R., Poulin, R. & Bascompte, J. (2010) Nestedness versus modularity in ecological networks: two sides of the same coin? *J. Anim. Ecol.* **79**, 811–817.

Fürst, M.A., McMahon, D.P., Osborne, J.L., Paxton, R.J. & Brown, M.J.F. (2014) Disease associations between honeybees and bumblebees as a threat to wild pollinators. *Nature* **506**, 364–366.

Gilarranz, L.J., Rayfield, B., Liñán-Cembrano, G., Bascompte, J. & Gonzalez, A. (2017) Effects of network modularity on the spread of perturbation impact in experimental metapopulations. *Science* **357**, 199–201.

Gotelli, N.J. & Graves, G.R. (1996) *Null models in ecology*. Smithsonian Institution Press, Washington DC, USA.

Griffin, R.H. & Nunn, C.L. (2011) Community structure and the spread of infectious disease in primate social networks. *Evol. Ecol.* **26**, 779–800.

Grünwald, P.D. & Grunwald, A. (2007) *The Minimum Description Length Principle*. MIT Press.

Guimarães, P.R. (2020) The structure of ecological networks across levels of organization. *Annual Review of Ecology, Evolution, and Systematics* **51**, null.

Guimerà, R., Sales-Pardo, M. & Amaral, L.A.N. (2007) Module identification in bipartite and directed networks. *Phys. Rev. E Stat. Nonlin. Soft Matter Phys.* **76**, 036102.

He, Q., Pilosof, S., Tiedje, K.E., Ruybal-Pesántez, S., Artzy-Randrup, Y., Baskerville, E.B., Day, K.P. & Pascual, M. (2018) Networks of genetic similarity reveal non-neutral processes shape strain structure in plasmodium falciparum. *Nat. Commun.* **9**, 1817.

Howe, H.F. (2016) Making dispersal syndromes and networks useful in tropical conservation and restoration. *Global Ecology and Conservation* **6**, 152–178.

Huffman, D.A. (1952) A method for the construction of Minimum-Redundancy codes. *Proceedings of the IRE* **40**, 1098–1101.

Hutchinson, M.C., Bramon Mora, B., Pilosof, S., Barner, A.K., Kéfi, S., Thébault, E., Jordano, P. & Stouffer, D.B. (2018) Seeing the forest for the trees: Putting multilayer networks to work for community ecology. *Funct. Ecol.* **1**, 55.

Jacob, U., Thierry, A., Brose, U., Arntz, W.E., Berg, S., Brey, T., Fetzer, I., Jonsson, T., Mintenbeck, K., Möllmann, C., Petchey, O.L., Riede, J.O. & Dunne, J.A. (2011) The role of body size in complex food webs: A cold case. *Advances in Ecological Research* (ed. A. Belgrano), vol. 45, pp. 181–223, Academic Press.

Kéfi, S., Miele, V., Wieters, E.A., Navarrete, S.A. & Berlow, E.L. (2016) How structured is the entangled bank? The surprisingly simple organization of multiplex ecological networks leads to increased persistence and resilience. *PLoS Biol.* **14**, e1002527.

Kheirkhahzadeh, M., Lancichinetti, A. & Rosvall, M. (2016) Efficient community detection of network flows for varying markov times and bipartite networks. *Phys Rev E* **93**, 032309.

Kivelä, M., Arenas, A., Barthelemy, M., Gleeson, J.P., Moreno, Y. & Porter, M.A. (2014) Multilayer networks. *J. Complex Networks* **2**, 203–271.

Krause, A.E., Frank, K.A., Mason, D.M., Ulanowicz, R.E. & Taylor, W.W. (2003) Compartments revealed in food-web structure. *Nature* **426**, 282–285.

Lambiotte, R. & Rosvall, M. (2012) Ranking and clustering of nodes in networks with smart teleportation. *Phys. Rev. E Stat. Nonlin. Soft Matter Phys.* **85**, 056107.

Leger, J.B. (2015) blockmodels: Latent and Stochastic Block Model Estimation by a 'V-EM' Algorithm.

Luczkovich, J.J., Borgatti, S.P., Johnson, J.C. & Everett, M.G. (2003) Defining and Measuring Trophic Role Similarity in Food Webs Using Regular Equivalence.

Marquitti, F.M.D., Guimarães, P.R., Pires, M.M. & Bittencourt, L.F. (2014) MODULAR: software for the autonomous computation of modularity in large network sets. *Ecography* **37**, 221–224.

Maynard, D.S., Serván, C.A. & Allesina, S. (2018) Network spandrels reflect ecological assembly. *Ecol. Lett.* **21**, 324–334.

McArt, S.H., Koch, H., Irwin, R.E. & Adler, L.S. (2014) Arranging the bouquet of disease: floral traits and the transmission of plant and animal pathogens. *Ecol. Lett.* **17**, 624–636.

Mello, M.A.R., Felix, G.M., Pinheiro, R.B.P., Muylaert, R.L., Geiselman, C., Santana, S.E., Tschapka, M., Lotfi, N., Rodrigues, F.A. & Stevens, R.D. (2019) Insights into the assembly rules of a continent-wide multilayer network. *Nat Ecol Evol* .

Memmott, J. (1999) The structure of a plant-pollinator food web.

Michalska-Smith, M.J., Sander, E.L., Pascual, M. & Allesina, S. (2018) Understanding the role of parasites in food webs using the group model.

Mouritsen, K.N., Poulin, R., McLaughlin, J.P. & Thieltges, D.W. (2011) Food web including metazoan parasites for an intertidal ecosystem in new zealand: Ecological archives E092-173. *Ecology* **92**, 2006–2006.

Mucha, P.J., Richardson, T., Macon, K., Porter, M.A. & Onnela, J.P. (2010) Community structure in time-dependent, multiscale, and multiplex networks. *Science* **328**, 876–878.

Newman, M.E.J. & Clauset, A. (2016) Structure and inference in annotated networks. *Nat. Commun.* **7**, 11863.

Newman, M.E.J. & Girvan, M. (2004) Finding and evaluating community structure in networks. *Phys. Rev. E Stat. Nonlin. Soft Matter Phys.* **69**, 026113.

Ohlsson, M. & Eklöf, A. (2020) Spatial resolution and location impact group structure in a marine food web. *Ecol. Lett.* .

Olesen, J.M., Bascompte, J., Dupont, Y.L. & Jordano, P. (2007) The modularity of pollination networks. *Proc. Natl. Acad. Sci. U. S. A.* **104**, 19891–198916.

Olesen, J.M., Dupont, Y.L., O'Gorman, E., Ings, T.C., Layer, K., Melián, C.J., Trøjelsgaard, K., Pichler, D.E., Rasmussen, C. & Woodward, G. (2010) From broadstone to zackenberg: space, time and hierarchies in ecological networks. *Advances in Ecological Research* (ed. G. Woodward), vol. 42 of *Ecological Networks*, pp. 1–69, Academic Press.

Peixoto, T.P. (2014) Hierarchical block structures and high-resolution model selection in large networks. *Phys. Rev. X* **4**, 011047.

Peralta, G., Stevani, E.L., Chacoff, N.P., Dorado, J. & Vázquez, D.P. (2017) Fire influences the structure of plant-bee networks. *J. Anim. Ecol.* **86**, 1372–1379.

Peterman, W.E., Ousterhout, B.H., Anderson, T.L., Drake, D.L., Semlitsch, R.D. & Eggert, L.S. (2016) Assessing modularity in genetic networks to manage spatially structured metapopulations. *Ecosphere* **7**, 384.

Pilosof, S., Fortuna, M.A., Vinarski, M.V., Korallo-Vinarskaya, N.P. & Krasnov, B.R. (2013) Temporal dynamics of direct reciprocal and indirect effects in a host-parasite network. *J. Anim. Ecol.* **82**, 987–996.

Pilosof, S., He, Q., Tiedje, K.E., Ruybal-Pesántez, S., Day, K.P. & Pascual, M. (2019) Competition for hosts modulates vast antigenic diversity to generate persistent strain structure in plasmodium falciparum. *PLoS Biol.* **17**, e3000336.

Pilosof, S., Porter, M.A., Pascual, M. & Kéfi, S. (2017) The multilayer nature of ecological networks. *Nature Ecology & Evolution* **1**, 0101.

Popa, O., Hazkani-Covo, E., Landan, G., Martin, W. & Dagan, T. (2011) Directed networks reveal genomic barriers and DNA repair bypasses to lateral gene transfer among prokaryotes. *Genome Res.* **21**, 599–609.

Poulin, R., Krasnov, B.R., Pilosof, S. & Thieltges, D.W. (2013) Phylogeny determines the role of helminth parasites in intertidal food webs. *J. Anim. Ecol.* **82**, 1265–1275.

Rezende, E.L., Albert, E.M., Fortuna, M.A. & Bascompte, J. (2009) Compartments in a marine food web associated with phylogeny, body mass, and habitat structure. *Ecol. Lett.* **12**, 779–788.

Rooney, N., McCann, K.S. & Moore, J.C. (2008) A landscape theory for food web architecture. *Ecol. Lett.* **11**, 867–881.

Rosvall, M., Axelsson, D. & Bergstrom, C.T. (2010) The map equation. *Eur. Phys. J. Spec. Top.* **178**, 13–23.

Rosvall, M. & Bergstrom, C.T. (2008) Maps of random walks on complex networks reveal community structure. *Proc. Natl. Acad. Sci. U. S. A.* **105**, 1118–1123.

Rosvall, M. & Bergstrom, C.T. (2011) Multilevel compression of random walks on networks reveals hierarchical organization in large integrated systems. *PLoS One* **6**, e18209.

Sah, P., Leu, S.T., Cross, P.C., Hudson, P.J. & Bansal, S. (2017) Unraveling the disease consequences and mechanisms of modular structure in animal social networks. *Proc. Natl. Acad. Sci. U. S. A.* **114**, 4165–4170.

Sander, E.L., Wootton, J.T. & Allesina, S. (2015) What can interaction webs tell us about species roles? *PLoS Comput. Biol.* **11**, e1004330.

Shannon, C.E. (1948) A mathematical theory of communication. *Bell Sys. Tech. J.* **27**, 379–423.

Stouffer, D.B. & Bascompte, J. (2011) Compartmentalization increases food-web persistence. *Proc. Natl. Acad. Sci. U. S. A.* **108**, 3648–3652.

Thébault, E. (2013) Identifying compartments in presence-absence matrices and bipartite networks: insights into modularity measures. *J. Biogeogr.* **40**, 759–768.

Thébault, E. & Fontaine, C. (2010) Stability of ecological communities and the architecture of mutualistic and trophic networks. *Science* **329**, 853–856.

Timóteo, S., Correia, M., Rodríguez-Echeverría, S., Freitas, H. & Heleno, R. (2018) Multilayer networks reveal the spatial structure of seed-dispersal interactions across the great rift landscapes. *Nat. Commun.* **9**, 140.

Truitt, L.L., McArt, S.H., Vaughn, A.H. & Ellner, S.P. (2019) Trait-Based modeling of multihost pathogen transmission: Plant-Pollinator networks. *Am. Nat.* **193**, E149–E167.

Tur, C., Sáez, A., Traveset, A. & Aizen, M.A. (2016) Evaluating the effects of pollinator-mediated interactions using pollen transfer networks: evidence of widespread facilitation in south andean plant communities. *Ecol. Lett.* **19**, 576–586.

Vázquez, D.P. & Aizen, M.A. (2003) NULL MODEL ANALYSES OF SPECIALIZATION IN PLANT–POLLINATOR INTERACTIONS. *Ecology* **84**, 2493–2501.

Yen, T.C. & Larremore, D.B. (2020) Community Detection in Bipartite Networks with Stochastic Blockmodels .