Managing the wicked problem of transdisciplinary team formation in socio-ecological systems

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1 **Introduction**

2 Socio-ecological problems have been described variously as messy (McCool & Guthrie 2001),
3 complex (Berkes, Colding, & Folke, 2003; NRC, 2005), and wicked (Carroll, Blatner, Cohn, &
4 Morgan, 2007; Xiang, 2013). High levels of uncertainty about ecological processes and
5 conflicting social values are at the heart of the messiness and complexity of socio-ecological
6 systems and, by implication, socio-ecological problems. The intractable nature of socio-
7 ecological problems has received considerable attention in recent years (Batie, 2008; Chapin et
8 al., 2008; Iovanna & Newbold, 2007; Miller & Barber, 2008), and land use planning and
9 management problems have frequently been addressed using a socio-ecological system
10 framework (e.g., Collins et al., 2000; Opdam, Steingrover, & van Rooij, 2006; Tzoulas et al.,
11 2007; van Kamp, Leidelmeijer, Marsman, & de Hollander, 2003; Xiang, 2013).

12
13 Identifying appropriate responses to wicked socio-ecological problems requires a
14 transdisciplinary approach to research and management (Brandt et al., 2013; Brown, Harris, &
15 Russell, 2010; Clark et al., 1999). A rich literature identifies a long list of challenges associated
16 with transdisciplinary research, including cognitive obstacles (Ramadier, 2004), lack of common
17 research framing (Brandt et al., 2013), unbalanced problem ownership (Lang et al., 2012),
18 methodological conflicts (Pohl & Hirsch Hadorn, 2008), and even establishing whether a
19 transdisciplinary approach is appropriate (Pohl, 2008). For this paper, we ground our analysis in
20 the proposition that these and other challenges make the *conduct* of transdisciplinary research a
21 wicked problem. For the purposes of this discussion, we limit our focus to the first stage in
22 conducting transdisciplinary research — the formation of research teams. Specifically, we argue
23 that transdisciplinary team formation is a wicked problem in its own right.

24

25 In the following sections, we first consider the definition of transdisciplinary and then distinguish
26 team formation as a preliminary stage in transdisciplinary research. Next, we consider the
27 evidence that team formation is a wicked problem, using characteristics of wicked problems
28 described by Rittel and Webber (1973). Finally, we offer a set of strategies for managing the
29 wicked problem of team formation, drawn from our experience working together on socio-
30 ecological research proposal development and other transdisciplinary initiatives, as well as from
31 lessons shared in the literature.

32

33 **Defining Transdisciplinarity**

34 Pohl (2008) traces transdisciplinarity to Jantsch (1972), who proposed that labels such as
35 multidisciplinary, interdisciplinary, and transdisciplinary describe the nature of coordination
36 occurring within science, education, and decision making. Stokols, Hall, Taylor, and Moser
37 (2008) suggest that the quality and level of intellectual integration are the distinguishing features
38 of multidisciplinary, interdisciplinary and transdisciplinary research teams. Multidisciplinary
39 research is conducted by researchers from different disciplines who work independently or
40 sequentially on separate parts of a common research problem (Rosenfield, 1992; Stokols et al.,
41 2008), achieving integration by stapler. In interdisciplinary research, researchers work jointly to
42 integrate disciplinary perspectives and address a common problem, but they remain anchored in
43 their home disciplines (Stokols et al., 2008). Transdisciplinary research has been characterized in
44 two similar but importantly different ways (Klein, 2008). For some, transdisciplinary research is
45 an integrative process where researchers work jointly to develop a "shared conceptual framework
46 that synthesizes and extends discipline-specific knowledge creating new models and language to

address a common research problem" (Stokols et al., 2008, p. S79). A second interpretation requires the inclusion of non-traditional research partners, taking it to be a collaborative process of knowledge production that involves multiple disciplines plus stakeholders from other sectors of society (Pohl, 2008), "trans-sector, problem-oriented research" (Klein, 2008, p. S117) benefiting from multiple sources of knowledge and ways of knowing (Brown, 2010).

Transdisciplinary research is needed when knowledge about socio-ecological problems is incomplete, when there is disagreement about the nature of problems, and when the problems and their solutions hold important implications for those affected by them (Pohl & Hirsch Hadorn, 2007). Transdisciplinary research "grasps the complexity of problems, takes into account the diversity of life-world and scientific perceptions of problems, links abstract and case-specific knowledge, and develops knowledge and practices that promote what is perceived to be the common good" (Pohl & Hirsch Hadorn, 2007, p. 20).

The Stages of Transdisciplinary Research

Defense of our thesis — that forming teams to pursue transdisciplinary research objectives is itself a wicked problem — requires that we identify and individuate *team formation* as a distinguishable part of transdisciplinary research. One way to analyze team formation in this sense is in terms of the stages of a typical collaborative transdisciplinary project. Carving up collaborative group projects into stages is a natural way of modeling how projects unfold, with Tuckman's (1965) "forming-storming-norming-performing" model of small group development an early and important conceptualization (see also Farrell, Schmitt, & Heinemann, 2001). This mode of analysis has also been applied to transdisciplinary projects, understood as structured,

goal-oriented decision making efforts (Lang et al., 2012; Lynam, de Jong, Sheil, Kusumanto, & Evans, 2007; Hall & O'Rourke, 2014).

Hall and O'Rourke (2014), for example, distinguish five transdisciplinary project stages: *framing*, *launching*, *integrating*, *generating*, and *deciding*. In the framing stage, project initiators identify and scope the problem and then make decisions about who will be involved in the effort. The project is launched when the team is assembled and the work is initiated; emphasis at this stage is on motivating and equipping the team to be effective. In a transdisciplinary project involving multiple perspectives, integration of those perspectives is crucial to success. The central outcome of adequately integrated points of view will be the generation of multiple project alternatives for assessment, setting up the team to make decisions in the fifth stage. To this list can be added a sixth stage, *evaluation*, in which the team and others evaluate their decisions and, based on that evaluation, conclude the project or return to a previous stage to address a project shortcoming.

As we understand *team formation*, it figures importantly into the *framing* stage of a transdisciplinary project, but it also includes what must take place in advance of this stage. The conditions that structure the framing stage derive from the initial project motivation, which will generally influence how a team is formed. A project could be initiated from the bottom up, perhaps by a curious or concerned individual or by a small group of people interested in working together, or from the top down by an administrator or funding agency that taps others to pursue project objectives. The framing stage could be entered by an established team, perhaps because they were selected for the effort by an administrator or because they wish to engage in a new

project, or by someone who builds a team. Two points deserve emphasis in the latter case. First, framing will involve identifying perspectives necessary to the success of the effort and then individuals who occupy those perspectives, making sure to select individuals who can also function effectively in groups and in that group in particular. Second, team constitution could proceed hierarchically, under the direction of a team leader or leaders, or in a more egalitarian fashion, reflecting an important difference in team function that is just as evident in this stage as in others.

We emphasize that this multi-stage division is somewhat artificial, imposing a set of clearly delineated stages on a process that is invariably messier in reality. Thus, we grant Rittel and Webber's (1973) point that what is needed here is an approach of the "second generation" in which an "image of the problem and of the solution emerges gradually", rather than one of a first generation "systems approach" in which planning is approached through a series of distinct phases (Rittel & Webber, 1973, p. 162). Transdisciplinary research projects rarely move through the stages in a single pass, instead looping back through the sequence iteratively in order to address aspects of the overall problem or perhaps repair damage induced by a bad decision (Pohl & Hirsch Hadorn, 2008). At any point in the life of a project, several of these stages might be manifest, running in parallel with one another in interrelated ways as the team zigzags toward its project objectives, engaging in "incessant judgment" and "critical argument" (Rittel & Webber, 1973, p. 162).

The Wickedness of Team Formation

Exploration of wicked problems and their many manifestations has blossomed since Rittel and Webber (1973) first brought attention to the wicked problems in planning. From a diverse body of work, examples include wicked problems in design theory (Buchanan, 1992), natural resource management (McCool & Guthrie, 2001), public health (Kreuter, De Rosa, Howze, & Baldwin, 2004), and public administration (Durant & Legge, 2006). Conklin (2006) has written about the value of collective intelligence for resolving wicked problems, arguing that much of the “pain” in organizations derives from approaching wicked problems as though they were tame (e.g., Conklin, 2006; Conklin & Weil, 2007). Others have described the growing reliance on problem-solving teams, collaboration, and feedback — that is, *teamwork* — for responding to and resolving wicked problems (e.g., Pacanowsky, 1995), and the team science literature offers insights into the challenges that arise in team work and how they might be overcome (e.g., Fiore, 2008). However, the challenge of forming such teams, especially given potential team members’ different worldviews, different forms of knowledge, and methodological diversity, has not been framed as a wicked problem, which is our intent here. While we believe that many, if not all, of the characteristics of wicked problems described by Rittel and Webber (1973) apply, we focus on four characteristics that are especially relevant to the challenges of forming transdisciplinary research teams.

1. There is no definitive formulation of a wicked problem

At first glance, the claim that forming teams to conduct transdisciplinary research is a wicked problem may seem mistaken. After all, while wicked problems and their solutions have “no definitive formulation” (Rittel & Webber, 1973, p. 161), it seems the problem of forming a transdisciplinary research team can be formulated with one straightforward instruction: combine

138 representatives of the appropriate communities together into a functional unity that can
139 accomplish the research objectives.

140
141 The first thing to note about this description of the process of forming transdisciplinary teams is
142 that it exhibits an important feature associated by Rittel and Webber (1973) with wicked
143 problems: the “process of formulating the problem and of conceiving a solution ... are identical,
144 since every specification of the problem is a specification of the direction in which a treatment is
145 considered” (p. 161). Characterizing team formation as a problem requires highlighting some
146 challenging aspects of the process of forming the team (e.g., identifying appropriate
147 communities, selecting research objectives), which will invariably indicate the direction in which
148 the treatment lies.

149
150 But even if we set this logical consideration aside, the appearance that transdisciplinary team
151 formation is a facile problem is deceptive. The “straightforward” instruction mentioned above
152 deceptively describes the problem of team formation and its treatment as definitive only because
153 team formation operates at a level of abstraction that supplies little guidance to participants in an
154 actual project. In particular cases, what counts as *appropriate* communities, adequate
155 *combination*, and a *functional* unity varies in ways that are unpredictable, difficult to identify,
156 and dynamic.

157
158 Let’s consider appropriateness. Team formation requires selecting both communities and
159 individuals that are deemed *appropriate* in light of the research question, but what counts as an
160 *appropriate* community is often unclear. There may be a few obvious communities that must be

161 included — this might be mandated by the request for proposals to which one is responding, for
162 example — but identifying other communities whose inclusion would enhance the effort can be
163 difficult at the framing and launching stages of team formation. Further, as the team works on the
164 project, it is not uncommon that its conception of the project changes, resulting in changing
165 attitudes about which communities should be represented and which needn't be. Both of these
166 considerations echo Rittel and Webber's (1973) claim that, when it comes to wicked problems,
167 "the problem can't be defined until the solution has been found" (p. 161).

168
169 There are, of course, standard heuristics for determining team membership, such as finding the
170 top experts in fields that are clearly implicated by the problem or including known or
171 recommended researchers or stakeholders with expertise in these fields (Huutoniemi & Tapio,
172 2014), but there is no prescribed formula for designating the communities that these team
173 members should represent. Even for experienced project participants, assessments of this
174 mutable aspect of transdisciplinary projects often are value judgments that vary from researcher
175 to researcher. Convictions that certain communities should be involved can differ, leading to
176 disagreement and even conflict.

177
178 Combination and functionality also present difficulty, as can be observed if we attempt to
179 formulate a response to the team formation problem. On the surface, success requires that team
180 members combine their perspectives effectively and produce the knowledge necessary to
181 accomplish the research objectives. Yet this condition presupposes a delicate balance among
182 team members that is challenging to create. For one thing, adding new people to the team
183 changes the intellectual and social dynamics, given that each member brings a different

perspective to the project. Adjustments in team composition will invariably change the problem of forming a functional team and the character of its solution (Isohanni, Isohanni, & Veijola, 2002). For another, even when the team is functional, the objectives can be a moving target, influenced by the dynamic attitudes of team members and the changing composition of the team (e.g., the loss of graduate students and post-doctoral researchers). The tricky aspects of selecting initial team members, adding or subtracting team members as objectives shift, and navigating through disciplinary conflicts suggest that the team leader will need to act as facilitator, rather than as manager, guiding members through processes that encourage their development into a cohesive team with a strong group identity and deep commitment to its product. The challenges of facilitating and retaining transdisciplinary team membership suggest that team formation is an ongoing process that could be as critical late in the lifespan of a project as it is in its youth, exhibiting Rittel and Webber's second characteristic of wicked problems expressed as "no stopping rule" (Rittel & Webber, 1973, p. 162).

2. Wicked problems have no stopping rule

This second characteristic of wicked problems has to do with not knowing when you are done. This lack of clarity derives from the uncertainty and, relatedly, complexity of the problem being addressed. Transdisciplinary team formation constitutes a problem that exhibits this characteristic for the following reason: since there is no clear answer to the question of correct team composition, there is no clear answer to the question of when to stop adding or subtracting team members.

206 Consider the creation of a research team to respond to a funding opportunity. When creating
207 teams within a single discipline, team formation and composition are relatively simple: the team
208 is made up of people within the discipline of the team leader. There is a question of how many
209 people to include, but this decision may be largely determined by the upper limit on the project
210 budget. Of course, every discipline has its subspecialty areas and choosing among them creates
211 some uncertainty; however, when choosing subspecialties from within one's own discipline, a
212 reasonably high degree of familiarity with the subspecialty areas and their potential contributions
213 can be assumed.

214

215 Determining the right mix of disciplinary expertise for a transdisciplinary research team is much
216 more complex. Uncertainty about which disciplines to include and when the mix of disciplines is
217 sufficient can be high, regardless of the team leader's discipline. If a team leader is putting
218 together a team to address a complex socio-ecological problem, she will understand that
219 contributions from both social sciences and natural sciences will be needed. A geographer team
220 leader who seeks experts in psychology and sociology likely understands that, while geographers
221 focus on spatial relationships, psychologists tend to study individual behavior, and sociologists
222 tend to study organizations or communities. However, she is less likely to be familiar with the
223 fundamental theory and methods of these other social sciences. One could also expect the
224 geographer team leader's familiarity with theoretical and methodological foundations of natural
225 science disciplines to be substantially less. The inclusion of team members from non-academic
226 communities alongside disciplinary experts can generate even more uncertainty. In a
227 transdisciplinary team that includes both representatives of academic disciplines and members of
228 non-academic communities, the team leader may have only the vaguest sense of the communities

229 that could be represented and how knowledge, perspectives and concerns in the communities
230 match up to the research problem or question (Lélé & Norgaard, 2005). (If the team leader is not
231 an academic, wading through the arcane definitions of disciplines in the academy to find the
232 right team members can be especially confounding!)

233

234 Knowing when to stop adding expertise to a team focusing on a complex socio-ecological
235 problem does not stem just from uncertainty about the potential contributions of different
236 disciplines or non-academic communities. In fact, because socio-ecological problems require
237 attention from a broad range of expertise, a team leader may find it equally challenging to know
238 when to stop adding team members simply because there are so many different types of expertise
239 that could contribute to the effort. Stopping points are typically reached here for reasons
240 “external to the problem” (Rittel & Webber, 1973, p.162), such as when team members believe
241 that some critical mass (or worse, token representation) of fields radically different from their
242 own has been reached rather than because of any confidence that the mix of members is a good
243 match for the problem focus. This scenario becomes even more difficult when the team leader
244 moves beyond academia to draw from interested industry, nongovernmental organization
245 (NGO), or agency staffs; the possibilities are endless, and it is difficult to know where to stop
246 (Conklin & Weil, 2007).

247

248 Another external consideration that can yield stopping points is the project budget. Yet, as a team
249 leader moves farther from his or her field of expertise, developing any real sense of the costs
250 associated with research is difficult. For instance, natural and engineering sciences are frequently
251 much more equipment-intensive than social sciences. On the other hand, social and natural

scientists at many universities frequently have heavier teaching loads compared to more applied colleges of natural resources or engineering. In the U.S., it is not uncommon for social and natural scientists to require a portion of the budget to buy out of teaching a course or two to give them time to participate in a project. This situation makes it challenging to determine how many scientists of various disciplines the budget will bear. These issues become even more muddled when researchers move beyond academia to the integration of industry employees, policymakers, or NGO staff. Budgeting expectations can be very different outside the academy, making it difficult to predict costs of including non-academics. Given that research teams frequently make decisions about how many people can be invited to participate based on the funder's maximum allowable budget, decisions about when to stop adding members are particularly difficult for leaders of transdisciplinary teams (Conklin & Weil, 2007).

As the research approach and process evolve through interaction of a transdisciplinary team's members, the need for new members with new expertise may become evident, such as when the project expands to accommodate new problems or new opportunities. Team composition can be modified at any time and may require modification as the problem is addressed. For example, turnover in personnel is not uncommon; attrition can break momentum and deprive the team of critical expertise, forcing the team to retool with new people. Further, reassessing roles or removing team members may be necessary. In principle, transdisciplinary team formation can be endless; every new member brings a new perspective and, potentially, ideas for other areas of expertise or stakeholder groups that should be included. And there are trade-offs. Adding new people has costs in terms of spreading the budget more thinly and potentially in disrupting the cohesiveness of the team.

275

276 3. Every solution is a “one-shot operation” and has consequences; there are no opportunities to
277 learn by trial and error

278 Because every attempt to solve a wicked problem counts significantly and every implemented
279 solution is consequential, every attempted solution is a “one-shot operation.” This characteristic
280 is exhibited by team formation, which brings a specific set of perspectives and skills together in
281 light of the way its research problem has been framed. Team formation is a “one-shot operation”
282 because any decision to invite new members to the team is a decision to invite new perspectives,
283 new expertise, and a new way of viewing the problem. In other words, the problem space is not
284 fixed. It changes with every change to the research team. The opportunity to learn by trial and
285 error is removed because the learning context changes. Thus, team formation is not merely a
286 matter of swapping alternatives in and out.

287

288 Compare this with solving a jigsaw puzzle, where you could use trial and error to determine
289 which of the remaining pieces of the puzzle fits into the spot you're currently working on.
290 Swapping puzzle pieces in and out doesn't change the context (i.e., the pieces that are already in
291 place), so you can make mistakes and keep going until the puzzle is completed. With the wicked
292 problem of team formation, by contrast, any time someone is added to the team, the context is
293 irrevocably changed. The opportunity to try a different collaborator while keeping the problem
294 framing fixed doesn't exist. The same is true when a particular team member isn't a good fit and
295 is replaced. In this case, the fact that a team member didn't work out likely signals that the team
296 experienced some difficulty, implying that the team dynamics will be different the next time
297 around.

298
299 Keeping in mind that wicked problems are “one-shot” operations, it is worth considering the
300 special case of team-based, transdisciplinary Ph.D. research. Established academics have the
301 luxury of choosing to continue or discontinue participation in transdisciplinary teams, but a
302 doctoral student’s dissertation is essentially a one-shot deal, and the student’s decision to
303 participate in transdisciplinary research may have profound implications for career opportunities.
304 Misgivings from doctoral students involved in an interdisciplinary Ph.D. program (Gardner,
305 Jansujwicz, Hutchins, Cline, & Levesque, 2012, p. 382) are illustrative:

306
307 “I think interdisciplinarity is a learning process. Essentially, the faculty doesn’t
308 have all the answers...” “Yeah ... I don’t know that the faculty members know. I
309 think this is iterative, and they’re learning with us.” “I guess so far I’ve been
310 getting the feeling that it’s sort of like an experiment and so my role is to just kind
311 of like participate as best I can in a positive way.”

312
313 We may encourage our students to participate in transdisciplinary research, and in doing so,
314 engage them in transdisciplinary teams, but we should be sensitive to the fact that they are
315 embarking on a wicked voyage that could fail, given all of the challenges of transdisciplinary
316 teams that we and others highlight.

317
318 4. Every wicked problem can be considered to be a symptom of another problem
319 Rittel and Webber (1973) describe problems as discrepancies between the way things are and the
320 way they ought to be. Attempts to solve a problem lead us to search for its cause. The cause is

often a problem as well; thus one problem is often a symptom of another problem. The problem of forming transdisciplinary teams can trace its wickedness to various causes, not the least of which is the observation that universities have disciplinary departments while the world has problems that transcend disciplinary boundaries (Brewer, 1999; Wilson, 2009). We do not suggest that disciplines are unimportant; transdisciplinarity assumes discipline-derived contributions. Yet, researchers who come to science with strong disciplinary boundaries are often unprepared for the need to go beyond disciplinary thinking in order to address complex problems (Freyer, Bingen, & Helgenberger, 2010).

In transdisciplinary research, each researcher brings to the table a way of viewing problems, a body of theory and methods that are distinctive to his or her home discipline (Eigenbrode et al., 2007). As a transdisciplinary team is being formed, the less experience team members have with crossing disciplinary boundaries, the more challenging it will be to agree upon how to proceed. Equally problematic for reaching agreement on problem definition, and hence team membership, are the (often unspoken and unchallenged) internal beliefs and values that come with disciplinary expertise (Lélé & Norgaard, 2005; Aslin & Blackstock, 2010). In addition, researchers who are most comfortable with conventional approaches to science struggle to understand other, non-academic ways of knowing and of framing problems (Freyer et al., 2010).

One way to address these problems is through transdisciplinary education (Stokols, 2013), but despite growing attention to transdisciplinary research needs, transdisciplinary graduate education programs are still relatively rare. Social science and humanities programs generally include little, if any, exposure to natural sciences in required coursework. Likewise, natural

science or engineering program requirements rarely leave space for venturing into social science classes. Even fewer programs of either type emphasize engagement with non-academic communities. There have been efforts to remedy this problem. For example, the United States' National Science Foundation's (NSF) Integrative Graduate Education and Research Traineeship program (Borrego & Cutler, 2010) provided competitive funding for universities proposing formal cross-disciplinary education and research opportunities for Ph.D. students. However, NSF does not at present plan to continue the longstanding program.

Once transdisciplinary teams begin to form and identify needed expertise, they may be unable to attract desired members. The problem here is that, before researchers can be convinced to participate in transdisciplinary research, the incentives must be right. Reasons why academic researchers may avoid participating with transdisciplinary teams are numerous (e.g., Brewer, 1999). Researchers may be unwilling to invest the extra time and effort required to participate actively in transdisciplinary research (Lélé & Norgaard, 2005), despite recognizing that their research of complex problems would benefit from collaborations with others. Researchers may fear compromising disciplinary depth for transdisciplinary breadth (Aslin & Blackstock, 2010). Participating on a transdisciplinary team might provide an opportunity to contribute disciplinary expertise, but it also might limit the ability to advance the discipline or focus on unique methodological interests. Finally, researchers may anticipate problems with publishing results in top-reputation disciplinary journals (Campbell, 2005). Although the number of cross-disciplinary journals is increasing, and many of them hold positions at or near the top of various ranking and impact indices (Porter, Roessner, Cohen, & Perreault, 2006), current disciplinary review and

reward systems push for publishing in top-ranked disciplinary outlets (Pfirman, Collins, Lowes, & Michaels, 2005).

These disincentives are particularly strong for junior researchers who are pursuing academic careers and running the promotion and tenure gauntlet. For example, when a candidate is being considered for tenure, academic units commonly look to members of the candidate's home discipline for a review of his or her credentials, which can be problematic when the candidate has a transdisciplinary research program and a record of publishing in cross-disciplinary journals (Pfirman et al., 2005). Strict disciplinarians likely do not read journals outside their disciplines, and they may not understand or appreciate how a candidate's disciplinary expertise (in theory and/or methods) has advanced transdisciplinary research efforts and contributed to resolution of complex research problems. Yet, transdisciplinary efforts benefit greatly by including junior researchers who can bring enthusiasm, newer research methods, and, in some cases, the benefits of exposure to cross-disciplinary research if they have graduated from universities where it is practiced and taught.

Experiences with forming and working as part of a transdisciplinary team can be positive or negative, and negative experiences generate problems for future team formation efforts. If the transdisciplinary team experience is satisfying to team members, they will be more disposed to working on transdisciplinary teams again. When deciding whether to join a transdisciplinary team, just as in any research effort, an individual will weigh the costs against the benefits. Individuals who involve themselves in studying transdisciplinary problems do so presumably because they find the process and its outcomes compelling in either an intellectual or a social

sense (or both). However, no matter how many times one serves on such a team, there will always be an activation energy to be overcome when working on transdisciplinary problems that is higher than when conducting purely disciplinary research. If a previous collaborative experience has been negative, even if an individual is willing to participate again, that adverse experience is likely to limit enthusiasm for the hard work of creating integrated knowledge (Salazar, Lant, Fiore, & Salas, 2012).

Addressing the Wicked Problem of Team Formation

Perhaps it is not surprising that, upon analysis, transdisciplinary team formation is a wicked problem; after all, Rittel and Webber (1973) focused on *planning* problems, which involve actors with many, and sometimes conflicting, worldviews. Team formation is precisely that type of problem. Formation of a transdisciplinary team is typically motivated by the desire to resolve a wicked, transdisciplinary problem, and forming the team is the first stage in responding to the problem. Team formation is a planning process that occurs in a social space where political, cultural, and scientific interests interact, creating a dynamic series of trade-offs that can only be evaluated as better or worse in light of results that often take significant time to unfold.

Because they are “one-shot” operations, wicked problems do not admit formulaic solutions (Rittel & Webber, 1973, p. 163); however, this does not mean that we can’t learn from experience and approach these problems with our eyes wide open, ready to be responsive to problem characteristics that resemble those we’ve seen before. Here, we offer eight suggestions on how to manage the wicked aspects of transdisciplinary team formation, grounded in the literature and our experience. They are *heuristics*, that is, defensible strategies and tactics for

addressing a problem that are motivated by how well they “fit” a particular situation (Huutoniemi & Tapio, 2014). As such, they should be followed only to the extent that they are sufficiently relevant to team formation in its specific context. We organize the recommendations into two categories that correspond to significant aspects of team formation: constituting a set of collaborators and enabling collaborators to become a team.

Constituting a Set of Collaborators

1. Aim for balance in representation of constituencies (e.g., disciplines, stakeholder groups)

As we have discussed at length, a particularly wicked hallmark of transdisciplinary team formation is that it is unclear what communities should be represented to deal with the problem at hand. Nevertheless, including roughly equal numbers of participants from the various constituencies from the beginning and attempting to maintain the balance throughout is important. Furthermore, the importance of contributions from the different constituencies should be emphasized and re-emphasized along the way. At least two benefits arise from following these advisories. First, integrating all constituencies from the beginning increases the chance that the full range of possibilities for setting the intellectual direction of the team will be explored and more innovative ideas will emerge. Second, team members, especially team leaders, should recognize that transdisciplinary teams are likely to experience tensions related to pre-conceived differences in power and status among the represented constituencies. Being sensitive to these tensions, by reiterating the significant perspectives that each constituency brings to the problem, will help to build trust among team members and offset the risk that some team members feel inferior (or superior) to others.

2. Aim to include people with collaborative, cross-disciplinary research skills

There are, as outlined earlier, many challenges related to crossing disciplinary and organizational boundaries. These challenges can be exacerbated when academics collaborate with NGO, agency, or industry staff. Thus, team leaders should choose team members very carefully. While collaborator expertise is one of the most important criteria to consider, we have found that skills in teamwork and in crossing disciplinary and organizational boundaries are equally important. Some individuals are naturally skilled in these ways, some who aren't do proceed to acquire the skills, and some who aren't will never acquire the skills. Transdisciplinary experience is a key indicator here. Inclusion of some individuals with positive prior experience on transdisciplinary teams can have positive impacts on the team as a whole (Contractor, 2013). Cummings and Kiesler (2005) found that working previously on a team is helpful for overcoming several barriers to successful transdisciplinary team formation. Skilled, experienced collaborators representing key areas of expertise will have the patience to endure the often time- and energy-consuming nature of transdisciplinary work. They will also be sensitive to the concerns of less skilled members and help them learn the ropes. But this can be taken too far: while Guimera, Uzzi, Siro, and Nunes Amaral (2005) showed that prior transdisciplinary team experience can promote team success, they also remarked that team success can actually be undermined if a team has many collaborators who have worked together before, presumably because prior relationships can lead to less flexibility toward new voices. This potential problem can be overcome, however, by team leaders paying special attention to the contributions of new team members.

3. Acknowledge institutional and professional reward structures

Rewards for transdisciplinary work are important, and they vary depending upon the circumstances of the team member. The bureaucratic organizations within which many of us work are infamously clumsy at boundary-crossing. However, some universities and agencies have prioritized boundary-crossing skills, especially those institutions that have placed special emphasis on environmental management out of recognition that there is a major need for transdisciplinary approaches. Relatedly, interdisciplinary and cross-organizational boundaries tend to be less problematic for many university departments or colleges of forestry, natural resources, or environmental management. Faculties of such units frequently are drawn from diverse disciplines, and many become highly skilled at transdisciplinary work because it is fundamental to their missions. Collaborators drawn from these organizations will be properly incentivized to engage in transdisciplinary work. For example, pressure to publish only in top-flight disciplinary journals for tenure, promotion, and raises may be smaller in these locations where so many faculty regularly publish in interdisciplinary journals.

4. Modify team membership as a team

As we argued above, the team formation stage is not something you occupy once and leave; given the length and difficulty of typical transdisciplinary projects, there will almost certainly be turnover in team composition. Successive iterations of transdisciplinary team efforts may result in some members leaving and new members joining. In these situations, the question of adding new members should be addressed by the team as a whole, as democratically as possible within project constraints (Bennett, Gadlin, & Levine-Finley, 2010). One note of caution, though: a team may be tempted to bring in a new member to address a problem, conflict, or question that seems intractable when, in fact, good teamwork and cross-disciplinarity among existing

members are needed. In some cases, experienced transdisciplinary researchers may effectively borrow from the scholarship of other disciplines if they are open to seeing things from a different perspective, without having to bring a new disciplinarian to the team. This scenario may be more likely when a core set of team members has prior experience working together.

Enabling Collaborators to Become a Team

1. Generate engagement with the transdisciplinary topic from the beginning

For the transdisciplinary team effort to be successful, team members should be fully engaged in the broader transdisciplinary topic. An important aspect of engagement is that the overall thrust of the project needs to resonate with members' individual research interests and competencies. Part of this requisite will be secured if good decisions are made about whom to invite, but another part will depend on mutual understanding within the team. If the overall thrust of the project is to be a function of the team's collective research interests and competencies, each team member should appreciate the skills and worldviews that collaborators bring to the table. Team members, though, may not understand other members' research interests and competencies until deep into the process. The enthusiasm of team members for the sub-disciplinary research interests and competencies of others may develop slowly and may need to be reinforced continuously.

2. Create a context conducive to mutual learning

As we suggested, Rittel and Webber's (1973) observation that "trial and error" approaches to transdisciplinary problems are inadequate is compatible with the importance of learning to do transdisciplinary work. In particular, learning will occur through repeated interaction of

teammates as they address the various aspects of their common problem. Of course, as in any situation, learning occurs if individuals are open both to observing what does or doesn't work and to applying those lessons later. Closely monitoring outcomes and making needed adjustments are hallmarks of the adaptive management approaches applied by researchers and managers responding to wicked socio-ecological problems (Folke, Hahn, Olsson, & Norberg, 2005; Watzin, 2007); fostering a formal "learning by doing" process (which is not the same as trial and error) when working toward successful transdisciplinary teamwork reflects an understanding of the wickedness of team formation. Experience shows that individual and group reflection on lessons learned during and after transdisciplinary team deliberations can be quite helpful (Stokols, 2013). Indeed, the growing literature on best practices for transdisciplinary team formation and facilitation gives new or even experienced transdisciplinary teams the chance to learn from the trials of others who have gone before them (Bracken & Oughton, 2006; Campbell, 2005). Formation of communities of practice for transdisciplinary research offers opportunities for group reflection and mutual learning (Patterson, Lukasiewicz, Wallis, & Rubenstein, 2013). All of these observations underscore the importance of creating a context within which collaborators are engaged in learning from their teammates as the project unfolds.

3. Be willing to change course

In forming a transdisciplinary team to address a transdisciplinary problem, one might try to fit the team to the problem, hoping to cover most of the relevant bases; alternatively, one might put a functional team together and aim it in the direction of the problem, tackling the specific aspects of the problem that open up for the team. In practice, it often works out in the second way; the team may work on a broad problem in the beginning, but it is very likely that the broad problem

focus will be narrowed to accommodate the research interests and competencies of team members. In the end we work where we can do good work, even if that means that our target shifts after we initially started thinking about it. This sort of flexibility is not a bad thing, and, more to the point, it reflects the reality that the wicked problem and its solution arise together.

4. Be prepared for the long haul

To be effective, transdisciplinary teams require significant time and meaningful interactions. Researchers have argued that transdisciplinary teams must pass through a developmental sequence to reach the point of optimal functioning (e.g., Farrell et al., 2001). A newly-formed transdisciplinary team may attempt to pass through these stages in its first project effort, but more than one effort may be required for success. Also, participation in training activities should lead to more efficient teamwork and empowering of team members (Levi, 2013). As long as team members are willing to accept that transdisciplinary team formation is an iterative process, with adequate leadership and reflection on their experience of working together they stand a good chance of developing a shared team culture.

A Final Observation

In general, approaches to team formation can be *proactive* or *reactive*, and both will typically be exhibited by a project over the course of its existence. In the proactive mode, decisions are made that close down the space of options, rendering team formation more manageable but in the process closing off options that might have made all the difference. In the reactive mode, the “solution” to a particular problem can seem obvious (“We need an economist!”), but this ignores the often-contingent character of problem development. While the commonly understood

550 approach to team formation (i.e., combine representatives of the appropriate communities
551 together into a functional unity that can accomplish the research objectives) seems
552 straightforward and tame, operationalizing it in particular cases will be wicked due to constraints
553 supplied by project motivation, the values of the participants, the exigencies of circumstance, and
554 the changing nature of the project as it moves toward its objectives.

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