

This is an Accepted Manuscript of an article published by Taylor & Francis Group in *Journal of Environmental Planning and Management*, on 08/01/2013, available online:

<http://www.tandfonline.com/10.1080/09640568.2012.738326>

Cite as: Rob D. Fish, Michael Winter, David M. Oliver, Dave R. Chadwick, Chris J. Hodgson & A. Louise Heathwaite (2014), 'Employing the citizens' jury technique to elicit reasoned public judgments about environmental risk: insights from an inquiry into the governance of microbial water pollution', *Journal of Environmental Planning and Management*, Volume 57, Issue 2, pages 233-253

RESEARCH ARTICLE

1 **Employing the citizens' jury technique to elicit reasoned public** 2 **judgments about environmental risk: insights from an inquiry into the** 3 **governance of microbial water pollution**

4
5 **Abstract.** Devising policy instruments and interventions that can manage and mitigate the risks
6 associated with microbial watercourse pollution is a significant concern of the contemporary
7 environmental protection agenda. This paper reports on the work of a citizens' jury that sought to
8 elicit reasoned public judgments about the nature and acceptability of these risks as they relate to
9 the role of livestock farming, and what might constitute socially acceptable and sustainable
10 pathways to their management. By exploring this issue through a logical and sequential process
11 of risk characterisation, risk assessment and risk management, the paper reveals how citizens'
12 juries can be used to contextualise and structure science-policy apprehensions of microbial
13 watercourse pollution, and highlight where priorities for innovation and intervention might lie.
14 Reactions and responses of participants to the jury process and its outputs, including
15 issues of social and practical impact of the exercise, are also considered. The jury
16 technique is argued to be useful in the way it cuts across disparate domains of responsibility and
17 expertise for the governance of environmental risks, and therein challenges decision makers to
18 think more broadly about the political, moral and economic framings of otherwise narrowly
19 conceived science-policy problems.

20
21 **Keywords:** water quality; livestock farming; risk assessment; public participation; citizens'
22 jury

23

24 **Introduction**

25 Effective management of the risks associated with livestock farming for water quality is a
26 significant concern of the contemporary environmental protection agenda (Kay *et*
27 *al.*, 2007; Vinten *et al.*, 2009; Muirhead and Monaghan, 2012; Edge *et al.*, 2012). In the
28 UK and wider Europe, for instance, it finds expression in debates surrounding the
29 implementation of new and evolving standards for ground and surface water quality
30 embedded in the mandates of the revised Bathing Water Directive, the Shellfish Waters
31 Directive and the Water Framework Directive (see Wyn-Jones *et al.*, 2011; Birk *et al.*,
32 2012). Defining and observing these standards with confidence is an area of considerable
33 scientific debate, though like other arenas of environmental risk and natural resource
34 management, the efficacy of any given set of policy instruments and practical
35 prescriptions will not stand and fall on scientific technical knowledge alone (Gregory *et*
36 *al.*, 2006). Measures to mitigate should, for instance, be considered proportionate to risks
37 arising, and responsibilities for action in this area clearly assigned and borne fairly. Such
38 issues are by no means settled, and exert influence on the policy and decision making
39 process in contested and politically uneven ways (Strachan *et al.*, 2011).

40 The purpose of this paper is to examine how interdisciplinary researchers and policy
41 makers might inform their understanding of the risks and uncertainties associated with
42 microbial water quality through the use of deliberative forms of environmental risk
43 assessment. In particular, it describes a process in which different perspectives on the
44 relationship between livestock farming and potential human exposure to pathogenic
45 micro-organisms were subject to the considered judgments of a citizens' jury. This is a
46 technique that has been elaborated and explored in detail in theories of deliberative
47 democracy, often specifically through recourse to issues of environmental decision

48 making and sustainability (e.g. Crosby, 1995; Smith and Wales, 2000; Ward *et al.* 2003;
49 Smith, 2003). Whilst not constituting a standard feature of policy and practice,
50 experimentation with the design aspects of the jury technique has also occurred as part of
51 a broader ‘participatory turn’ within environmental decision making (Bloomfield *et al.*
52 2001; Burgess and Clark 2007; Reed, 2008), and includes examples from such diverse
53 areas as waste management (Petts, 2001), air pollution (PSP, 2006), wetland creation
54 (Alfred and Jacobs, 1997), flood plain management (Kenyon *et al.*, 2003), and GM crops
55 (FSA, 2000). The relationship between these techniques and other analytical aspects of
56 environmental decision making processes, such as cost-benefit and multi-criteria analysis
57 has also been an area of innovation and review (e.g. Aldred and Jacobs, 2000; Kenyon
58 and Nevin, 2001; Kenyon *et al.* 2001; Rauschmayer and Wittmer, 2004; Alvarez-Farizo,
59 and Hanley, 2006

60 The following account has two objectives in the context of this evolving literature.
61 First and primarily, it is designed to report on the way policy and scientific imperatives
62 for the management and mitigation of microbial risks are interpreted and assigned
63 significance by the public through a structured jury process, and to explore corresponding
64 implications for researchers and policy makers. Secondly, it offers further insight into the
65 design, conduct and utility of the citizens’ jury technique for marrying participatory
66 techniques to issues of high technical or scientific complexity, including a qualitative
67 assessment of participant reactions and responses to involvement.

68 The paper begins by scene-setting the relationship between watercourse pollution and
69 livestock farming, attending to key issues which define this relationship as a policy
70 ‘problem’, and outlining the research context in which the case for enacting a citizens’
71 jury was made. It then goes on to outline the theoretical issues involved in defining the
72 aims and scope of a jury process and the way we practically initiated and ran the jury

73 proceedings. Key findings from the process are then summarised and discussed, and its
74 outcomes evaluated. By exploring this environmental issue through a logical and
75 sequential process of risk characterisation, risk assessment and risk management, the
76 paper reveals how citizens' juries can be used to contextualise and structure science-
77 policy apprehensions of microbial watercourse pollution, and highlight where priorities
78 for innovation and intervention may lie.

79 **Research context**

80 The citizens' jury described here formed part of a programme of interdisciplinary
81 research examining how best to monitor, apportion and mitigate microbial risks within
82 farm environments in high risk landscapes. The specific geographical context for this
83 research was the Taw Catchment of north Devon, England. Laboratory and field-based
84 assessments of microbial dynamics in different environmental media (Hodgson *et al.*,
85 2009), combined with extensive interviews with farmers regarding of the nature of
86 livestock management practices (Selfa *et al.*, 2010) constituted the primary empirical
87 outcomes of this research. The research has resulted in the development of prototypical
88 risk assessment tools designed to inform more sustainable management of land and
89 livestock at the field and farm level (Oliver *et al.*, 2009; 2010a) as well as critical analysis
90 of the catchment scale governance arrangements guiding policies in the study area (Winter
91 *et al.*, 2011).

92 The case for employing the jury technique emerged specifically out of the
93 interdisciplinary 'talk' that shadowed this unfolding programme of empirical research. In
94 developing its work, the research team readily acknowledged and reflected that, while
95 frameworks for structured assessments of microbial risk have immediate purchase on
96 issues of management, they rest on a deeper and unresolved set of uncertainties. At one
97 level, the environmental protection agenda surrounding the loss of faecal bacteria and

98 potential pathogens from land to water through livestock farming is well established. In
99 the UK, approximately 90 million tonnes of livestock manures are produced annually
100 (Smith *et al.*, 2001), the majority of which requires collection, storage and spreading to
101 land. In addition, excreta from grazing livestock are deposited on land. A proportion of
102 these manures and excreta contain pathogenic micro-organisms which humans may be
103 exposed to in a variety of ways: by ingesting water through recreational activities such as
104 bathing and surfing; by engaging in activities in countryside environments such as
105 camping, walking and visits to farms; and through the consumption of food, such as
106 contaminated shellfish or from salad crops irrigated with contaminated water (Graczyk *et*
107 *al.*, 2007; Heaton and Jones, 2008; Ogden *et al.*, 2002; Campos *et al.*, 2011). If humans
108 are exposed to certain pathogenic micro-organisms in sufficient numbers they may
109 experience gastro-intestinal illness, the implications of which are understood to be varied.
110 Microbial infection can prove fatal for some people (e.g. young children, the elderly and
111 those with a weak immune system). However, more commonly symptoms include nausea,
112 stomach cramps, vomiting and diarrhoea. Gastro-intestinal illness caused by *E. coli* O157
113 alone has been estimated to cost the UK around £30M annually in healthcare and over £1
114 billion per annum in lost productivity (Jones, 1999). Over and above this, the implications
115 of public health scares on regional economies dependent on competitive leisure and
116 agricultural sectors, as well as industries more generally reliant upon clean water, such as
117 shell fisheries, are potentially significant (Bridge *et al.*, 2010).

118 Progress is being made in developing techniques that can track the origins of these
119 risks (Reischer *et al.*, 2011) but there are uncertainties regarding the extent to which
120 culpability can be attributed to either human or environmental sources (Chadwick *et al.*,
121 2008; Oliver *et al.* 2010b). Alongside research into ‘source apportionment’ scientists are
122 now experimenting in the use of techniques that might help livestock farmers to mitigate

123 these risks. These techniques include: changing the way slurries and manures are stored;
124 enhancing the composting of solid manures; exporting manures from the farm; reducing
125 stocking levels; reducing the number and volume of applications; fencing off
126 watercourses and creating grass buffer strips (see Oliver *et al.*, 2007). The efficacy of
127 these approaches is by no means clear and all demand the investment of time and money.
128 Scientific research is thus beginning to tell us many things about how these risks may
129 function, and evaluating a range of ‘hard’ and ‘soft’ technical options that may be
130 employed to reduce them. Yet, it is policy makers who must develop practical responses
131 in ways that marry this evidence base with proportionate forms of action. They need to
132 design interventions that reflect the significance of these risks and ensure that approaches
133 to mitigation are not only effective, but good value. And they need to develop
134 mechanisms that allow responsibilities for taking action against these risks to be properly
135 assigned, and any costs incurred borne fairly.

136 It is these issues and questions that provided the rationale for the citizens’ jury. The
137 process was formally sponsored by the Water Quality Division of the Department for
138 Environment, Food and Rural Affairs (DEFRA), the government department with
139 responsibility for fostering sustainable rural development in England and Wales. In
140 essence, the Water Quality Division is a science-facing policy group embedded in wider
141 national level debates about water policy. At one level the Division agreed to support the
142 process as an experiment in, what was to them, a novel public engagement methodology;
143 one in step with the wider needs of policy delivery. At the same time, the process
144 occurred at a time, in 2008, of a Department-led consultation on recent revisions to the
145 EU Bathing Water Directive, with jury verdict ultimately considered as a formal
146 submission to this consultation. Nonetheless, it is important to note that this was an
147 unanticipated outcome from the perspective of the project team. The jury’s funding

148 context, and therein its links to a real world policy consultation, was not anticipated in
149 advance. It was not conceived originally with ambitions to steer or shape policy at the
150 national level. Rather the motivating factor was initially about an area of science-policy
151 led research engaging with its underpinning rationales and priorities by exploring the
152 views, experiences and expertise of those who sit outside formal circuits of authority,
153 interest or expertise. That is to say, it was first and foremost conceived as a device to
154 encourage greater reflexivity on the part of natural and social scientists about whether and
155 how microbial watercourse pollution is understood as an object of risk governance, and
156 what these assessments then imply for prevailing modalities of scientific praxis,
157 regulatory activity, and interventions in livestock farming. Furthermore, while it is
158 common for citizens' juries to be constructed to address pragmatic local concerns
159 (Niemeyer and Spash, 2001), the jury did not originally set out to directly answer
160 questions of a vernacular local expression - namely how to directly foster tangible
161 changes to livestock management in the Taw Catchment. However, as we shall see, an
162 interesting outcome of this work was the way it anticipated models and approaches to
163 microbial risk mitigation that have since been employed in the study area and elsewhere.

164 **Citizens' juries and analytic-deliberative assessments of risk**

165 The protocols guiding the application of citizens' jury techniques have been already
166 described at length in the academic and grey literature (Armour, 1995; Coote and
167 Lenaghan, 1997, Smith and Wales, 1999; Veasey, 2004), and we summarise these
168 briefly here. Broadly put, citizens' juries involve a small cross section of the general
169 public (a 'jury'), usually between 10-20 people, coming to a considered judgment (or
170 'verdict') about a stated policy issue through detailed exposure to, and scrutiny of, the
171 relevant evidence base. This evidence base is presented to the jury in the form of oral and
172 written testimony at a formal jury event (the 'proceedings') which lasts between two and

173 three days, either as a ‘one-off’ process, or staggered over a period of time. Evidence is
174 presented to the jury by those with particular interests or expertise in the given topic area
175 (the ‘witnesses’). The task of the jury is to assimilate this information and interrogate
176 witnesses about the nature and substance of their claims/arguments as the basis for
177 responding to a pre-given ‘question’, ‘charge’ or ‘dilemma’. The response is provided in
178 a written and oral form after the jury proceedings have taken place, and is collectively
179 endorsed by the jury. This general approach guided our own approach to jury conduct.

180 In this study, the guiding approach to jury design is most closely aligned to the work of
181 Chilvers (2007) and, in particular, his assessment of approaches to risk governance that
182 are ‘analytic-deliberative’ in style. As Chilvers explains, analytic-deliberative
183 methodologies are shorthand for forms of science-citizen interaction that seek to link
184 together technical/quantitative approaches to risk governance with more
185 interpretive/qualitative participatory processes. A modest body of experimental
186 methodological work is emerging examining how jury techniques can be employed as
187 part of an analytic-deliberative process. Novel approaches to environmental valuation are
188 one facet of this work (see Neiymer and Spash 2001) some of which are being developed
189 specifically in the context of water management at the catchment scale (Alvarez-Farizo
190 and Hanley, 2006; Alvarez-Farizo *et al.*, 2007).

191 For Chilvers (2007) the ideal structure of an analytic-deliberative process encompasses
192 three key stages - termed ‘framing’, ‘assessing’ and ‘management/action’ - within which
193 science, citizens and stakeholders interact in different ways depending on the type of
194 approach employed. At each stage, steps are logically encountered which duly
195 characterise the priorities of these interactions. Thus the ‘framing’ stage includes, for
196 instance, a process in which problems are defined and acceptability criteria are shaped,
197 while the ‘assessing’ stage encompasses issues of data collection, and its subsequent

198 interpretation and synthesis. The ‘management/action’ stage involves, in turn, a process in
199 which option are evaluated, decisions are made, and ultimately, actions are monitored and
200 evaluated. Within this schematic, citizen juries are understood to be a platform for
201 ‘dialogic interactions’ between scientific and non scientific forms of expertise, and in
202 particular ones that potentially involve:

203 “non specialists adopting evaluative or extended peer review roles in questioning the
204 conduct, quality, uncertainties and interpretations of ‘core’ scientific analyses, as well
205 as contributing alternative framings of the issues considered” (*Ibid.* 202).

206 It is precisely these roles and contributions that we sought to enable through the jury
207 process: in effect one in which citizens would expose the core scientific analysis of
208 microbial water course pollution and livestock farming to critical scrutiny and provide
209 (potentially) alternative ways of framing interfaces between science, policy and practice.
210 This generic analytic-deliberative framework also provides a useful way of understanding
211 the underpinning questions which ultimately guided the jury process. In particular, in our
212 project the parameters of debate outlined above were developed as a set of sequential and
213 connected themes that ultimately mirror the three stages envisaged by Chilvers, namely

214	Acceptability	<i>What risks arise from the microbial pollution of water</i>
215		<i>courses and how significant are they?</i>
216	Culpability	<i>What are the origins of these microbial risks and how</i>
217		<i>culpable are livestock farming practices within them?</i>
218	Necessity	<i>What more could reasonably be done to mitigate the impact</i>
219		<i>of livestock farming practices on water quality?</i>
220	Responsibility	<i>Where do responsibilities begin and end when controlling</i>
221		<i>these microbial risks arising from livestock farming?</i>

222 Thus, the jury process was designed to begin with the issue of problem framing, where
223 the issue was about critically evaluating the nature and acceptability of microbial risk,
224 then move through more precise issues of assessment, where uncertainties surrounding
225 the origins of microbial risk are considered, and then into issues of management and
226 action, encompassing debates about the nature of reasonable action and how to assign
227 responsibilities.

228 The sequential logic of this process is worth emphasising. It is not possible to form
229 judgments about how to assign responsibilities for risk management without first
230 addressing the way these risks should be managed. Equally, it is not possible to address
231 questions of management without first coming to a judgment over how these microbial
232 risks originate and behave within the environment, which in turn depends on accepting
233 these risks to be potentially significant in some way. In other words, this ‘narrative based’
234 approach to ‘issue framing’ is designed to guide the jurors through the parameters of the
235 debate in a rational way. Importantly, it carries with it the virtue of exposing, and
236 therefore potentially subjecting to critique, prevailing wisdoms about the nature of the
237 problem at hand and what should be done about it. So, for instance, in addressing the
238 issue of ‘acceptability’ a jury might plausibly conclude that microbial risks are
239 unimportant and in so doing question the (otherwise unstated) significance assigned to the
240 issue in science policy agendas. To what extent this way of ‘storyboarding’ jury dilemmas
241 reflects the real world of decision making and problem framing is debatable, for in
242 practice the policy debates embedded in each of these themes tend to run in parallel, and
243 often in isolation. As such this approach knits together the social and environmental
244 relations of risk in a way that would not otherwise be likely in conventional policy
245 discourse. Consequently, we consider this narrative approach to be a useful way of

246 deciphering the complex and unruly nature of governing environmental risks in an
247 integrated and holistic fashion.

248 In advocating this it is important to emphasise that the way in which the issues are
249 framed is strongly defined by the *a priori* work of the project team, and this potentially
250 carries with it a tension with regards to how publics are implicitly structured in
251 participatory processes as recipients of pre-determined problems. Thus, opportunities are
252 required that allow for the acceptability of such a framework to be critically inspected,
253 and potentially transformed, by the jury itself. In our case, this framework was open to
254 scrutiny in advance of the jury proceedings by jurors, but was strongly endorsed.

255 **Approach to jury formation**

256 Conducting a citizens' jury raises important issues regarding the character and
257 composition of the jury (Kenyon and Nevin, 2001). Populating a jury is not only
258 conditioned by the need to reflect a good cross section of society, but beset with wider
259 debates over ideas of 'competence' - the extent to which members of the public are
260 capable of addressing the issue at hand - and 'bias' - the extent to which a jury can be
261 constituted in such a way as to avoid overt and overriding investments in the issue at
262 hand. In our jury process, the project team considered that establishing a balanced jury in
263 terms of age, gender, ethnicity, and area of residence (urban and rural) was a necessary
264 aspiration. At the same time the project team accepted a longstanding position in the
265 sociology of risk by conceptualising the public as 'experts in their communities'
266 (Corburn, 2007; Irwin, 1995). We took it as axiomatic that - providing the microbial story
267 was itself coherent and clear in its stated dilemmas - a lay jury would be able to return a
268 reasoned judgment through collective deliberation. Thus the project team regards
269 'absolute' definitions of expert knowledge - where authority to exert influence over the
270 design of policy is based, for instance, around formal credentials - as unnecessarily

271 reductionist. Furthermore, it was recognised that groups involved in public engagement
272 exercises will always carry with them particular investments in an issue, and that these
273 investments can be a virtue as much as an implied drawback. The idea that there exists a
274 jury with no *a priori* interest in this issue, however indirect, was considered problematic.

275 Even so, it seems important to acknowledge here that the jury comprised individuals
276 living in Devon, UK, an area with a strong livestock farming tradition and one
277 inextricably tied to wider debates about the sustainability of local landscape and economy
278 (including tourism). Whether this means that the judgments of the jury would be
279 inherently more ‘pro-farming’ than those of a jury constituted from a different
280 geographical context is an interesting question, though out of the scope of this inquiry. As
281 we shall see, the conclusion of the jury certainly carries with it a supportive message for
282 the farming fraternity. Nonetheless, given the origins of the wider research project in
283 Devon, it was considered reasonable that participants would be drawn from across the
284 county itself and the jury process would use the Taw Catchment as a platform upon which
285 wider science and policy issues could then be given practical expression.

286 It is in this context that the jury for the main event was recruited via a ‘free find’
287 process. This involved designing a press release in conjunction with the public relations
288 department of the host University, which was circulated to the regional press and radio
289 and posted on its institutional website. This process resulted in a number of articles on the
290 jury process being written in the regional press and live interviews being conducted on
291 BBC and commercial radio. In total, 37 people who responded to this publicity expressed
292 a serious interest in participating. We distinguished respondents to this process in three
293 ways. First, a major response grouping was ‘interested lay environmentalists’ as a
294 respondent type, by which we mean members of the public who responded to the
295 publicity out of intrinsic interest/concern in environmental issues, but with no formal

<i>Table 1 about here</i>

296 training or background in the issues being treated by the jury. In addition, a number of
297 respondents were practicing farmers or people who came from a farming background, or
298 were people who held or had held professional roles (outside of farming) which related to
299 an aspect of the jury issue, such as agricultural consultancy, microbiology and water
300 management. A small number of respondents were drawn from the university sector who
301 were currently studying, or had recently studied, for degrees relating to the jury topic
302 (such as in biosciences). In practical terms this experience suggests that, to secure interest
303 in processes such as these, the most effective means of free find communication is via a
304 locally circulated newspaper article (Table 1).

305 Of these 37 respondents, 13 were selected to participate at the event. The view was
306 taken that these persons should be drawn predominantly from the interested ‘lay’
307 grouping, rather than those with specialist credentials. In total nine people were drawn
308 from this lay grouping to which was added: one respondent brought up on a farm (but not
309 a farmer *per se*); one with some background in microbiology (a school teacher); one who
310 was a retired (organic) sheep farmer; and one who was a recent university graduate in
311 Geography with technical knowledge relevant to the Jury. A further two persons, both
312 aged 17, were purposively recruited by the jury facilitator because it was judged that the
313 demographic profile of the recruitment process was skewed towards a more senior age
314 profile. These individuals were drawn from a local Further Education College in
315 consultation with its AS Environmental Science course leader. All of the jurors lived in
316 Devon and a good geographical spread across the county was achieved. The ratio of
317 women to men on the jury was 2 to 1. The mean age was 47 years.

318 Debates surrounding the constitution of a jury tend to be inverted in the construction of
319 an evidence base. There is, of course, a need to frame understandings of jury themes in a
320 representative way, but here the issue is about staging a discussion in such a way that

321 different types and levels of professional investment are exposed and brought to the fore.
322 In our case we structured the jury process to span philosophical as well as technical
323 debates, and for this reason, the evidence base is potentially very wide. It also relies on
324 a highly purposive approach to expert recruitment. Many of the protagonists with
325 investments in these debates work in tightly delimited policy areas. They are named
326 individuals with precise areas of expertise and responsibility. Even in areas where
327 evidence may be produced by a number of individuals (such as in the presentation of
328 scientific evidence), the need to recruit those with proven and well established track
329 records is arguably important to strategic policy interest in the process and its outcome. In
330 total, 18 witnesses were recruited to participate in our jury process combining a mixture
331 of scientific experts and professional stakeholders from across the public, private and
332 third sector (see Table 2). They included witnesses from government departments,
333 statutory bodies, water utilities, unions and pressure groups, scientific and policy
334 researchers in universities and institutes, as well as from the farming community.

<i>Table 2 about here</i>

335 **Enacting a jury and returning a verdict**

336 In the run up to the proceedings, both witnesses and jurors were provided with guidance
337 notes on the scope and nature of a citizens' jury and the key questions which we, the
338 convenors, anticipated the process would explore. These notes included an exploratory
339 narrative characterising the relationship between microbial risks and agriculture and an
340 introduction to the way policy makers and researchers interact with this issue in terms of
341 types of regulation and basic and applied scientific research. Jurors attended a pre-jury
342 event where this information was re-presented to them through formal presentation and
343 then open discussion, and where they also learnt more regarding what the process would
344 involve in practical terms. At this juncture, participants were also provided with witness
345 statements and, where offered by a witness, supplementary written evidence to support

346 understanding of presentations at the main proceedings. An opportunity to reframe the
347 initial questions laid down by convenors was given to jurors, but in practice the initial
348 questions were actively endorsed. Our experience suggests that a pre-event was helpful in
349 clarifying misconceptions about the nature of the issue which cannot be anticipated in
350 written guidance. They also build confidence among the participants. Indeed, some of our
351 participants initially were worried that they had no formal authority to address the debate,
352 that they would make wild and unfounded recommendations of little use to anyone. We
353 held this pre-event a fortnight before the main proceedings: sufficiently near to the real
354 event to build momentum; sufficiently distant to give time for jurors to consider
355 materials.

356 The event itself took place in two, quite different, settings: a civic space in an urban
357 (city) area and a scientific research institute in the countryside, with a working livestock
358 farm. In the first setting, jurors considered issues of a more abstract nature (i.e. dilemmas
359 of ‘acceptability’ and ‘culpability’); in the second those of a more applied and practical
360 nature (i.e. ‘necessity’ and ‘responsibility’). As part of this second phase jurors attended a
361 short walking tour of a farm and visited a laboratory where testing for pathogenic micro-
362 organisms takes place. In the proceedings short witness presentations were followed by
363 juror questioning. In our process, questioning rights were reserved exclusively for jurors
364 while the physical space was organized in such a way as to reflect the asymmetrical
365 power of the process, with observing witnesses located behind the main proceedings.

366 After each exploratory theme was considered jurors were required, during a closed
367 discussion, to discuss this evidence and form a partial response (or ‘verdict’) on the given
368 issue at stake (such as ‘acceptability’) that could then be revisited at the end of the jury
369 process. Constructing this response invariably involved further cross-examination of
370 witnesses, for instance, where uncertainties of understanding existed among group

371 members or where jurors wished to probe witnesses on key arguments. These responses
372 were constructed initially in a discursive fashion with the jury chair closing the section
373 with agreed summary of key points. At the end of the two day event participants reviewed
374 these responses as the basis for communicating an oral verdict to all participants. This
375 was primarily designed to ‘book-end’ the formal proceedings and was effectively an
376 interim verdict.

377 A formally written verdict for detailed consideration by jury sponsors and other
378 participants was then constructed. This written verdict was achieved by the jury
379 facilitator transcribing the discussions and conclusions of jurors - which were sound
380 recorded in their entirety - and creating a draft written statement that reflected key
381 conclusions and where degrees of consensus emerged. This statement was then
382 collectively endorsed by the jury through an iterative process of document feedback and
383 review,. It took one month to achieve the final wording of this verdict. Complexities arise
384 when forming an agreed statement because responses to these issues were rarely
385 definitive in group discussion. In our experience this reflects, in part, the challenge of
386 ensuring that jurors can adequately pursue the kind of open ended questions, (technical,
387 ethical and economic and so forth) naturally raised by these processes given the breadth
388 of the subject and the time available, as well as the stated intention to use the jury to think
389 about an issue in integrated way. It also, of course, reflects fundamental differences of
390 positionality and world view. Consensus building through deliberation is one normative
391 facet of arguments surrounding the use of this technique, but we would argue that
392 deliberation is also partly about clarifying, rather than necessarily reconciling, differences
393 of juror perspective and outlook on a given issue. In this, iterations of the verdict turned
394 on grafting a statement that the jury could agree in terms of majority and minority views
395 on each of the issues. In this way the focus was on communicating a coherent overall

396 message rather than a consensus verdict *per se*. The role of jury facilitator and chair in
397 developing forms of words acceptable to all is acknowledged here, and places the
398 researchers close to Pielke's (2007) idea of the scientist as a 'broker' of views and options
399 at the interface of policy making and society. Taking these issues into account the
400 following sub-sections report on the principal claims of the jurors with respect to the four
401 jury themes namely: acceptability; culpability; necessity; responsibility.

402 *Acceptable risks?*

403 We began the event by asking participants to consider evidence and views on the
404 significance of the risks associated with microbial watercourse pollution as the basis for
405 thinking through the issue of acceptability. Participants were asked to consider risks to
406 public health and risks to the economy based on the testimonies of five expert witnesses.
407 From a public health perspective, presentations to the jury were provided by the Health
408 Protection Agency, Food Standards Agency and Surfers Against Sewage and focused on
409 contextualising microbial watercourse pollution in relation to different types of
410 environmental hazards and their potential to cause harm, not only biological hazards, but
411 also chemical, radiological, nuclear and industrial. The purpose here was to situate
412 microbial risks within a wider landscape of risks to human health, and to convey how
413 these are understood by policy makers and interest groups alike. These witness
414 viewpoints were followed by presentations from representatives of shell fisheries and the
415 regional tourist board where the ramifications of the risks for wider economic actors in
416 region were emphasised. On the basis of this evidence the majority view of the jury was
417 that current risks to human quality of life arising from the microbial pollution of
418 watercourses were *relatively* insignificant. The jury made this judgment whilst
419 recognising that the public health and economic implications of such pollution could be
420 serious. It was careful to recognize that risks to human health or economic prospects

421 would be unacceptable to those who bear the burden of these risks directly, such as those
422 infected by *E. coli* O157 or those attempting to secure a viable shell fish industry. Yet the
423 majority of the jury was strongly of the view that the risks arising were, in general
424 societal terms, insignificant when set against the wider scheme of risks to human quality
425 of life.

426 Within this context the jury considered it unrealistic to interpret watercourses as
427 systems that can be entirely free of risks to human quality of life. It argued that policy
428 makers seeking to manage and regulate microbial water course pollution should therefore
429 recognise that ‘zero risk’ is a problematic standard against which to assess the efficacy of
430 its interventions. Moreover, the jury suggested that the significance policy makers assign
431 to this issue may partly reflect the relatively short timescales around which microbial
432 risks tend to manifest themselves. When weighing up their priorities they suggested that
433 policy makers should therefore take great care to incorporate into their assessments other
434 risks that may well be more important, but have much longer, ‘lead-in’ times. Risks
435 associated with industrial legacies, such as contaminated land, were cited as a case in
436 point here. While the jury felt that these microbial risks may be considered relatively
437 insignificant, and to some extent inevitable, their acceptability depended on programmes
438 of research being funded that not only seek to improve mitigative action, but anticipate
439 new developments in the environments they study. In this latter respect, the jury was
440 strongly of the view that the significance of these risks may increase in the future given
441 the likelihood of greater episodic incidents related to climate change. Microbial risks
442 were only acceptable in the context of measures being taken that reflect the best available
443 scientific knowledge and which are sensitive to changing circumstances.

444 The jury further considered the ongoing monitoring frameworks for these risks in
445 England could be enhanced through greater cross-agency working. In particular, based on

446 the evidence presented, it was felt that there may be unrealised possibilities for statutory
447 organisations (such as the Environment Agency) to conduct more extended monitoring
448 for faecally-derived micro-organisms in the course of their work and which may provide
449 an important contribution to the scientific evidence base of government departments
450 (such as Defra) with direct responsibility for this policy area.

451 *Culpable risks?*

452 It has been noted above that progress is being made in developing techniques that can
453 track pathogen found in watercourses to their source. In the jury we sought to convey to
454 participants how this science is conducted and reported on by academic researchers,
455 regulators (the Environment Agency), industry (the water utility, South West Water) and
456 public health specialists (the Health Protection Agency). An important dimension of this
457 was to convey an understanding of the uncertainties associated with this science. At one
458 level livestock farming was revealed in the proceeding to be but one protagonist in the
459 debate regarding ‘culpability’. For instance, it is widely recognised that pathogenic risks
460 may arise not only from agriculture, but also from human sewage and other
461 environmental sources (such as from wild animals). The key underpinning questions
462 considered in this section of the Jury, then, were ‘with what confidence can it be claimed
463 that livestock farming has a bearing on these microbial risks’, and ‘to what extent is it
464 able to attribute these risks to a particular failing in enterprise management’? Evidence
465 presented thus considered the relative role of livestock farming compared to other sources
466 and the way in which researchers conceptualise the specific risks associated with
467 livestock farming. Empirical research findings were drawn from monitoring work both
468 nationally and regionally and a specific case of investigating a recent regional outbreak of
469 *E. coli* O157, which was eventually tied to cattle grazing in fields upstream, was
470 presented and critically analysed.

471 It is against this context that the jury took the majority view that, with regard to
472 culpability, livestock farming currently played a significant role in contributing to
473 incidents of microbial watercourse pollution compared to human and other environmental
474 sources. The scientific evidence was considered credible in this respect, though for a
475 small number there was some ambiguity on the basis of evidence presented with regards
476 to the significance of wild animals and human sewage treatment systems. Moreover, the
477 jury cautioned that the significance of these risks will inevitably be relative to the
478 prominence of livestock farming within particular areas, and further, that no two livestock
479 farmers will be the same in terms of their attitudes and capacities to manage and mitigate
480 these risks. The jury also noted the possibility of increased storm events relating to
481 climate change may mean that the status of the water industry as a relatively low
482 contributor to microbial risk could be quite different in the future.

483 *Necessary risks?*

484 The jury explored approaches to mitigation. This dimension of the process involved a
485 structured field walk around a working (research) farm, allied to a mixture of
486 presentations wherein natural and social scientific researchers outlined the potential
487 options available to reduce risks and their associated costs, not only farm based, but also
488 downstream approaches, such as improving signage at bathing water locations. The
489 pragmatic focus of the evidence presented at this stage gave rise to a broad ranging
490 exploration of the idea of ‘proportionate’ intervention. In their assessment of mitigation,
491 the jury considered ‘extreme’ options, such as withdrawing livestock from the land, or
492 advocating overall reductions in UK livestock numbers *per se*. However, these measures
493 were considered not only disproportionate to the significance of the risks in question, but
494 would carry with them negative trade-offs. They might, for instance, raise problems
495 regarding the provision of animal welfare, increase dependency on imports for livestock

496 products, amplify diffuse pollution coming from cultivated land, as well as jeopardize the
497 propagation of biodiversity on farmed landscapes.

498 In general terms, the jury suggested that measures should centre primarily on
499 programmes of advice and training, and that there exist bodies of good practice
500 information produced by policy stakeholders that should act as the basis for farm
501 standards and guidance. It was felt that this information should be widely disseminated
502 and linked to systems of financial assistance that emphasise low cost and low technology
503 solutions in step with existing patterns of farming activity. In other words, given the
504 assessment of low risk significance, but high culpability, jurors sought to strike a careful
505 balance between the need for mitigative action and financial burdens on enterprises.
506 Nonetheless, it is also noteworthy that the jury felt there was a strong case for imposing
507 financial penalties on farmers where there have been incidents of microbial pollution
508 linked to episodic failings in enterprise management. It was suggested that farmers should
509 look to insure themselves for these potential failings. The jury was less convinced that
510 mitigative measures at the ‘user end’ of risks, (such as the provision of ‘live’ bathing
511 waters information or leaflets at bathing locations) was an effective approach to the
512 management of these risks (c.f. Stidson, *et al* 2011). Signage was regarded as potentially
513 incongruous to the surroundings, while leaflets are often ignored. These efforts were
514 considered potentially useful but the jury felt that mitigation at ‘source’ should be the
515 primary focus of intervention.

516 ***Who’s responsible?***

517 In the final session of the event the jury contextualised further its assessment of types of
518 intervention by exploring where burdens of responsibilities for action should lie. Jurors
519 heard the views of regulators (environment agency), government (Defra) farming bodies
520 (the National Farmers Union), and practising farmers. They were informed of the

521 mandatory responsibilities that farmers are obliged to meet to help reduce these risks,
522 such as those pertaining to ‘Codes of Good Agricultural Practice’, but also the potential
523 for voluntary forms of action, such as participation in the England Catchment Sensitive
524 Farming Initiative and agri-environmental stewardship schemes, and through quality
525 assurance schemes, such as the FABBL Farm Assurance Scheme. Responding to this
526 information, the jury suggested that the state, not farmers, should play the major role in
527 funding programmes of assistance and mitigation. The jury was clear that those with
528 policy responsibility for water quality must influence the design of agri-environmental
529 schemes so as to produce outcomes conducive not only to the enhancement of
530 biodiversity, but issues of environmental protection as well. Designing scheme options
531 that produce these multiple benefits was considered important. However, the jury felt that
532 the state has good reason to pursue options that specifically strengthen funding for the
533 mitigation of pathogenic organisms. We should note here that this was a highly perceptive
534 intervention by the jurors; one that challenges how objectives of environmental
535 stewardship schemes have been historically imagined. More generally, the jury expressed
536 some concern that failing to influence the design of stewardship schemes in this way may
537 carry with it the implication that the burden of costs will fall directly on farmers alone.
538 The jury considered this unacceptable. Indeed, it suggested that unlike other potentially
539 ‘polluting’ industries - such as the chemical industry, the nuclear industry, the
540 incineration/landfill industry and the water industry, the market would not allow farmers
541 to pass on the costs of mitigation directly to the consumer. This was felt to be problematic
542 for these risks are the product, in part, of wider consumer demand for livestock products
543 and the need to be competitive in the market.

544 The jury also suggested that microbial watercourse risks were, in a significant sense,
545 about one industry (livestock farming) potentially polluting another (shell fisheries). For a

546 minority of the jury this raised the interesting question as to the extent to which the public
547 purse should pay for an ‘industry problem’. Pragmatically it was felt that the shell fish
548 industry might look to develop systems of cross-industry subsidy given the potential
549 difference that an uptake of low cost measures in the livestock industry may make for
550 profit margins in aquaculture. In this the jury actually anticipated subsequent policy
551 developments in that it indicated potential public support for models of risk management
552 based on ‘payments for ecosystem services’ (Defra, 2010). Indeed, this approach has
553 subsequently been developed and applied in the case study area with the regional water
554 utility now paying livestock farmers to adopt management practices that protect
555 downstream water quality.

556 **Reactions and responses of participants to the jury process and its outputs**

557 Alongside this verdict the research undertook a formal evaluation of the process by
558 surveying participating witnesses and jurors through written feedback and structured
559 questionnaire. In general terms the witnesses suggested that the citizens’ jury technique
560 was a novel way of encouraging active public participation and scrutiny of the policy
561 process. As one put it:

562 “I thought the idea of a jury was an interesting concept as it provides members of
563 the community with an opportunity to question agencies and organisations
564 directly on a particular topic. It seems a good mechanism for encouraging healthy
565 debate”.

566 Many witnesses suggested that the process had value because, besides the substantive
567 verdict itself, the very process of conducting a jury - where scientists stand alongside
568 policy makers, interest groups and practitioners and speak to the bigger issues that define
569 and motivate their work - was as one suggested, “a departure” from what is “normal”. It
570 was widely felt that the process was also a useful way of gaining a deeper understanding

571 of public priorities about the issue at hand and how different areas of sectoral
572 responsibility were perceived in relation to this. In this respect one participant suggested,
573 he left with a clearer understanding of how the public “viewed” his sector. Most also
574 welcomed the opportunity to both shape and learn from public understandings and
575 perceptions of the issue. As one put it, the process was a means of “directly influencing
576 the understanding of the community”, and an interesting experience in that it demanded
577 experts to “deliver messages to an audience in ‘real’ terms i.e. that which a reasonable
578 layman could understand”. This latter witness concluded that “perhaps the opportunity to
579 deliver [messages in this way] to other such groups should be something we do more of
580 as an organization”. Notwithstanding our own recognition of the trade off between issue
581 complexity and the time dedicated to the proceedings, it was clear too that witnesses had
582 confidence in the process to produce a level of engagement that was appropriate to the
583 issue in hand:

584 “It was very enlightening to attend the citizens’ jury. The panel showed an
585 excellent depth of insight and discussions with individuals showed the breadth of
586 their backgrounds and understanding”

587 “The jury asked intelligent questions and were obviously putting a lot of thought
588 into the process. I was encouraged by the points the jury made which gave me
589 confidence that their final decision would be a valid one”

590 Citizens’ juries are often explained primarily, if not exclusively, as public engagement
591 techniques, but it was also clear from undertaking this exercise that witnesses considered
592 this process to have been an opportunity for cross-sectoral communication in ways that
593 would not be normally possible. There was sense in which the format of the jury process
594 was able to bring stakeholders into dialogue with each other.

595 “I thought it was a particularly effective way to bring together and facilitate
596 discussion between diverse interest groups which may not easily be achieved by
597 more traditional consultation processes. It was also a useful opportunity for me to
598 meet colleagues from Defra and elsewhere.

599 “It was good for me to get a feel of where the other witnesses were coming from –
600 it will help shape our future campaigning on this issue”

601 “It was a good opportunity for me to meet and talk to the other witnesses, as this is
602 a subject that I have a particular interest in professionally, especially as Cornwall
603 has a long coast line and a strong farming ethos”.

604 “It allowed me to hear about viewpoints from representatives of other stakeholders
605 concerned. I had several good conversations with people from other sectors and I
606 think we all went away a little better informed about other people's perspectives
607 and issues. Therefore the chance to network in this respect was indeed valuable”

608 “I felt that the jury was an interesting way of encouraging participation from a
609 wide range of the public and organizations in discussing a subject area which
610 affects us all ”

611 Finally, it was considered by some as a way of building confidence in the public image of
612 policy makers, in this case Defra. One witness suggested that:

613 “If nothing else, the Citizens’ Jury process will, I think, begin to help restore some
614 street cred to Defra’s public image. They should, if only for this reason, continue
615 to invest the relatively small sums involved in the Citizens’ Jury process...I
616 believe Citizens’ Juries processes have a vital part to play - if, and it’s a big if, the
617 outcomes are fed into the policy formulation process, rather than simply a sop to
618 the principles of consultation. It is to be hoped that ...Defra will continue the

619 stakeholder engagement with interest groups and parties and that the results will
620 be used at least to help shape and frame policy decisions. It is to be hoped that it
621 won't simply end up on some senior civil servant's desk stamped DONE and go
622 no further"

623 As this point suggests, the link to outcomes is important. Many witnesses indicated that
624 would read the judgments of the jury with interest, and would disseminate them widely
625 amongst peers. In this the processes tends to be constructed as relevant in its outputs, but
626 diffuse and informal in its overall impact. This partly reflects the jury's placement with
627 an exploratory research process rather than a real decision process. However, the
628 unanticipated link to the Bathing Waters Directive consultation has already been noted,
629 although again the precise impact of this is difficult to discern. As Defra formally, if
630 obliquely. stated in their responses to these findings, the juror's conclusions would be put
631 "into the mix" of consultation responses. There is currently no evidence for wider uptake
632 of this technique occurring in the sponsoring department .

633 For participating jurors, the evaluation questionnaire revealed the process to be
634 "enjoyable" or "hugely enjoyable" with the majority of participants regarding the
635 technique as "useful" exercise in assisting decision makers in understanding public
636 priorities about policy issues. A small proportion considered it "very useful" in this
637 respect. However, some respondents raised specific concerns about the importance of
638 jury composition and representativeness, and specifically that there might have been a
639 greater number of people in the 18-40 age range group. This would have brought "better
640 balance" to the proceedings. Another suggested that perhaps the jury was slightly
641 "biased" in its pro-farming view of the issue:

642 "I think it only became apparent towards the end of the process that the overall
643 'balance' of [juror] opinion could have been better. Personally, I felt the views of

644 the farming fraternity were over-represented on a number of vital aspects under
645 discussion and I sensed their influence on younger panel members.”

646 Half of the respondents to the survey felt that the sponsoring Government Department
647 Defra would take the verdict either ‘seriously’ or ‘very seriously’. Others were less
648 confident or suggested it was “impossible” to gauge the Department’s response. At the
649 same time, most participants regarded the technique as ‘useful’ or ‘very useful’ exercise
650 in informing the public about the policy process. As one suggested:

651 “I feel overall that the public have a right to be informed and express views, and
652 this type of process is a good way of reviewing evidence and making a guided
653 judgement, which can be used by policy makers to inform, guide and influence
654 developments in the public and community interest”

655 However, one respondent cautioned that using this technique to inform the wider public
656 was valuable in so far as it depended on the results of the Jury being publicized widely in
657 the Media. Indeed, there was felt to be a distinction between informing a small group of
658 the public about an important policy debate, and influencing the understanding of a wider
659 public.

660 **Conclusion**

661 In the analysis above we have sought to present a simplified account of a highly
662 interpretative, and qualitatively rich, process of public engagement in the issue of
663 microbial watercourse pollution. We set the terms of reference for this experiment
664 broadly. Starting from a platform of interdisciplinary applied research our concern was to
665 explore the political, economic and moral, as well as scientific complexities, embodied in
666 this environmental protection agenda. The need to build coherent policy narratives out of
667 such varied and often contested domains of debate should, of course, be a natural

668 aspiration for rational policy formation (and the development of corresponding platforms
669 of scientific research), though it is one that rarely occurs in practice. Indeed, one of the
670 interesting problems facing environmental managers and decision makers, not least those
671 working in the area of microbial watercourse pollution, is how to devise holistic
672 understanding of, and approaches to environmental problems, for they are never the
673 preserve of one area of responsibility and expertise alone. Our experience of conducting
674 this experiment was that the technique was useful in the way otherwise disparate areas of
675 authority, expertise and influence could logically explore the issue of microbial
676 watercourse pollution together.

677 Building a jury verdict sequentially around an exploration of issues of ‘acceptability’
678 ‘culpability’ ‘necessity’ and ‘responsibility’ was, we suggest, important to this outcome.
679 As we have shown, this structured process served to animate the potential of new models
680 of working (such as in the case for cross-industry subsidy), invite new types of policy
681 analysis (such as re-evaluating the place of environmental protection within agri-
682 environmental schemes), flag up areas of poor institutional working (such as
683 arrangements for integrated monitoring), subvert the technocratic orientation of science-
684 policy research agendas (by prioritising low cost, low technological interventions) and put
685 the status of microbial risks into wider perspective (for instance, by considering these
686 risks ‘relatively insignificant’). The technique, in other words, has utility in the way it
687 challenges prevailing research and policy orthodoxies and highlights areas of potential
688 innovation.

689 Yet, if our findings suggest that the technique has the potential to elaborate
690 environmental issues in constructive, critical and creative ways, the process of building
691 institutional and political capacities to capture and act on well-reasoned public insights
692 such as this, including reflexivity in applied research is, of course, an altogether more

693 vexed issue. . In this we recognise our citizens' jury had some degree of artificiality to it.
694 The provenance of our experiment was in a programme of exploratory interdisciplinary
695 research which coupled insightful results with diffuse, and generally informal, impacts.
696 Although critical and practical exposition of the 'ideal' of deliberative democracy
697 periodically serves to re-energise interest in the citizens' jury technique, policy makers
698 and researchers are some distance from harnessing the potential of these process to help
699 contextualise better the nature of science and policy priorities in a complex, if often silo-
700 driven world of decision making. It seems time to view this technique as something more
701 than methodological curiosity; a helpful if slightly unconventional appendage to the 'real
702 stuff' of public engagement in decision making.

703

704 **References**

705

706 Alvarez-Farizo, B. and Hanley, N., 2006. Improving the process of valuing non-market
707 benefits: combining citizens' juries with choice modelling. *Land Econ*, 82, 465–478 .

708

709 Álvarez-Farizo, B., Hanley, N., Barberán R., and Lázaro, A. (2007) Choice modeling at
710 the 'market stall': individual versus collective interest in environmental valuation, *Ecol.*
711 *Econ.* 60, 743–751.

712

713 Aldred, J., Jacobs, M., 2000. Citizens and wetlands: evaluating the Ely citizens` jury.

714 *Ecological Economics*, 34, 217-232.

715

716 Armour, A. 1995. The Citizens' Jury model of public participation: a critical evaluation.
717 In: O.Renn, T. Webler, and P. Widemann, P, eds. *Fairness and Competence in Citizen*
718 *Participation*. Dordrecht: Kluwer, 175-188
719
720 Birk, C , Bonne, W., Borja, A., Brucet, S., Courrat, A., Poikane, S., Solimini, Avan de
721 Bund, W., Zampoukas, N. and Hering, D. (2012). Three hundred ways to assess Europe's
722 surface waters; an almost complete overview of biological methods to implement the
723 Water Framework Directive. *Ecological Indicators*, 18, 31-41
724
725 Bloomfield, D., Collins K., Fry, C., Munton R., 2001. Deliberation and inclusion:
726 vehicles for increasing trust in UK public governance? *Environment and Planning C:*
727 *Government and Policy*. 19, 501 – 513
728
729 Bridge, J.W., Oliver, D. M., Chadwick, D., Godfray, H. C. J., Heathwaite, A. L., Kay, D.,
730 Maheswaran, R., McGonigle, D. F., Nichols, G., Pickup, R., Porter, J., Wastling, J., and
731 Banwart, S. A., 2010. Engaging with environmental science for public health benefits:
732 waterborne pathogens and diseases in the developed world. *Bulletin of the World Health*
733 *Organisation*. 88, 873-875.
734
735 Burgess, J. and Clark, J., 2007. Evaluating public and stakeholder engagement strategies
736 in environmental governance. In: A.Peirez (ed.) *Interfaces between science and*
737 *society*, London: Greenleaf Press, 225-252
738
739 Carlos J. A. Campos, Simon Kershaw, Ron J. Lee, Owen C. Morgan and Kevin Hargin
(2011) Rainfall and river flows are predictors for b-glucuronidase positive Escherichia

740 coli accumulation in mussels and Pacific oysters from the Dart Estuary (England) *Journal*
741 *of Water and Health*, 9, 368–381

742

743 Chadwick, D. R., Fish, R.D., Oliver, D.O., Heathwaite, A.L., Hodgson, C.J., Winter,
744 M., 2008. Management of livestock and their manure to reduce the risk of microbial
745 transfers to water - the case for an interdisciplinary approach. *Trends in Food Sci.*
746 *Tech.* 19, 240-247.

747

748 Chilvers, J., 2007. Towards analytic-deliberative forms of risk governance in the UK?
749 Reflections on learning in radioactive waste, *Journal of Risk Research*, 10, 197-222.

750

751 Corburn, J., 2007. Community knowledge in environmental health science: co
752 producing policy expertise. *Environmental Science and Policy*. 10, 150-161

753

754 Coote, A. & Lenhaglan, J., 1997. *Citizens' Juries: From Theory to Practice*. London:
755 Institute of Public Policy Research.

756

757 Crosby, N., 1995. Citizens Juries: One Solution for Difficult Environmental Questions. In
758 O. Renn, T. Webler and P. Wiedemann (Eds), *Fairness and Competence in Citizen*
759 *Participation*, pp. 157-174. London: Kluwer Academic Publishers

760

761 Defra, 2010. *Payments for ecosystem services: A short introduction* London: Defra

762

763 Edge, T.A., El-Shaarawi, A., gannon, V., Jokinen, C., Kent, R., Khan, IUH, Koning, W.,
764 Lapen, D., Miller, J., Neumann, N., Phillips, R., Robertson, W., Schreier, H., Scott, A.,

765 Shtepani, I., Topp, E., Wilkes, G., van Bochove, E., 2012. Investigation of an Escherichia
766 coli environmental benchmark for waterborne pathogens in agricultural watersheds in
767 Canada. *Journal of Environmental Quality*, 41, 21-30
768

769 FSA, 2000. *FSA Citizens' Jury: Should GM Food Be Available To Buy In The UK?*
770 Final Report. London: Food Standards Agency
771

772 Graczyk, T. K., Sunderland, D., Tamang, L., Lucy, F. E. and Breysse, P. N., 2007.
773 Bather density and levels of *Cryptosporidium*, *Giardia*, and pathogenic microsporidian
774 spores in recreational bathing water. *Parasitology Research*, 101, 1729-1731.
775

776 Gregory, R., Failing, L., Ohlson, D., and McDaniels, T. L. 2006. Some pitfalls of an
777 overemphasis on science in environmental risk management decisions. *Journal of Risk*
778 *Research*, 9, 717-735.
779

780 Heaton, J. C. and Jones, K., 2008. Microbial contamination of fruit and vegetables
781 and the behaviour of enteropathogens in the phyllosphere: a review. *Journal of Applied*
782 *Microbiology*. 104, 613-626.
783

784 Hodgson, C. J., Bulmer, N., Chadwick, D. R., Oliver, D. M., Heathwaite, A. L., Fish, R.
785 D. and Winter, M. 2009. Establishing relative release kinetics of faecal indicator
786 organisms from different faecal matrices. *Letters in Applied Microbiology*, 49, 124-130.
787

788 Irwin, A., 1995. *Citizen Science: A Study of People, Expertise and Sustainable*
789 *Development*. London: Routledge.

790 Jones, D. L., 1999. Potential health risks associated with the persistence of
791 *Escherichia coli* O157 in agricultural environments. *Soil Use and Management*. 15,
792 76-83.
793

794 Kay, D., Edwards, A. C., Ferrier, R. C., Francis, C., Kay, C., Rushby, L., Watkins, J.,
795 McDonald, A. T., Wyer, M., Crowther, J. and Wilkinson, J., 2007. Catchment
796 microbial dynamics: the emergence of a research agenda. *Progress in Physical*
797 *Geography*. 31, 59-76.
798

799 Kenyon, W. and Nevin, C., 2001. The use of economic and participatory approaches
800 to assess forest development: a case study in the Ettrick Valley. *Forest Policy and*
801 *Economics*. 3, 69-80
802

803 Kenyon, W., Hanley, N., and Nevin, C., 2001. Citizens' juries: an aid to environmental
804 valuation? *Environment and Planning C*, 19, 557-566.
805

806 Kenyon, W., Nevin, C., and Hanley, N., 2003. Enhancing Environmental Decision
807 making using Citizens' Juries. *Local Environment*, 8, 221-232.
808

809 Kenyon, W., 2005. Critical Review of Citizens' Juries: How Useful are they in
810 Facilitating Public Participation in the EU Water Framework Directive? *Journal of*
811 *Environmental Planning and Management*. 3, 431-443.
812

813 Niemeyer, S., & Spash, C. L. 2001. Environmental valuation analysis, public deliberation,
814 and their pragmatic syntheses: a critical appraisal. *Environment and Planning C-*
815 *Government and Policy*, 19(4), 567-585.

816

817 Muirhead R.W. & Monaghan R.M. (2012). A two reservoir model to predict *Escherichia*
818 *coli* losses to water from pastures grazed by dairy cows, *Environment International* 40, 8-
819 14.

820

821 Ogden, I. D., Hepburn, N. F., MacRae, M., Strachan, N. J. C., Fenlon, D. R., Rusbridge,
822 S. M., and Pennington, T. H., 2002. Long-term survival of *Escherichia*
823 *coli* O157 on pasture following an outbreak associated with sheep at a scout camp.
824 *Letters in Applied Microbiology*, 34, 100-104.

825

826 Rauschmayer, F and Wittmer, H., 2004. Evaluating deliberative and analytical methods
827 for the resolution of environmental conflicts *Land Use Policy*, 23,108-122

828

829 Reed, M.S., 2008. Stakeholder participation for environmental management::a literature
830 review. *Biological Conservation*, 141, 2417e2431.

831

832 Oliver, D. M., Fish, R. D., Hodgson, C. J., Heathwaite, A. L., Chadwick, D. R. and
833 Winter, M. 2009. A cross-disciplinary toolkit to assess the risk of faecal indicator loss
834 from grassland farm systems to surface waters. *Agriculture, Ecosystems and*
835 *Environment*, 129, 401-412.

836

837 Oliver, D. M., Heathwaite, A. L., and Haygarth, P. M., 2010b. A ‘culture’ change in
838 catchment microbiology? *Hydrological Processes*, 24, 2973-2976.
839

840 Oliver, D. M., Heathwaite, A. L., Hodgson, C. J. and Chadwick, D. R., 2007. Mitigation
841 and current management attempts to limit pathogen survival and movement in farmed
842 grasslands. *Adv. Agron.* 93, 95-152.
843

844 Oliver, D. M., Page, T., Heathwaite, A. L., Hodgson, C. J., Chadwick, D. R., Fish, R. D.,
845 Winter, M. 2010a. Development and testing of a risk indexing framework to determine
846 field-scale critical source areas of faecal bacteria on grassland. *Environmental Modelling*
847 *and Software*, 25, 503-512.
848

849 Petts, J., 2001. Evaluating the Effectiveness of Deliberative Processes: Waste
850 Management Case-studies. *Journal of Environmental Planning and Management.* 44,
851 207-226
852

853 Pielke, R.S., 2007. *The Honest Broker: Making Sense of Science in Policy and Politics*
854 Cambridge: Cambridge University Press.
855

856 PSP, 2006. *Articulating public values in environmental policy development. Report*
857 *on the Citizens’ Jury on Air Quality for the Department for the Environment, Food*
858 *and Rural Affairs.* London: People, Science and Policy.
859

860 Reischer, G. H. Kollanur D., Vierheilig J., Wehrspaun, C., Mach, R.L Sommer, R.
861 Stadler, H. and Farnleitner, A.H. Hypothesis-Driven Approach for the Identification of
862 Fecal Pollution Sources in Water Resources *Environ. Sci. Technol.*, 2011, 45, 4038–4045
863
864
865 Schets, F. M., van den Berg, H. H. J. L., Engels, G. B., Lodder, W. J. and Husman, A.
866 M. D. R., 2007. *Cryptosporidium* and *Giardia* in commercial and non-commercial
867 oysters (*Crassostrea gigas*) and water from the Oosterschelde, the Netherlands.
868 *International Journal of Food Microbiology*. 113, 189-194.
869
870 Selfa, T, Fish, R. And Winter, M., 2010. Farming livelihoods and landscapes: tensions in
871 rural development and environmental regulation *Landscape Research*, 35, 595 - 612
872
873 Stidson, RT, Gray, CA, and McPhail, C. 2011. Development and use of modelling
874 techniques for real-time bathing water quality predictions. *Water & Environment Journal*,
875 26, 7-18
876 Strachan, NJC, Hunter, CJ, Jones, CDR, Wilson, RS, Ethelberg, S, Cross, P, Williams,
877 AP, MacRitchie, L, Rotariu, O, Chadwick D. 2011. The relationship between lay and
878 technical views of *Escherichia coli* O157 risk. *Phil Trans Ro Soc B*. 366, 1999-2009.
879
880 Smith, G., and Wales, C., 1999. The theory and practice of citizens' juries. *Politics and*
881 *Policy*, 27, (3), 295-308
882
883 Smith, G., and Wales, C., 2000. Citizens' juries and deliberative democracy. *Political*
884 *Studies*, 48, (1), 51-65.

885

886 Smith, G. 2003. *Deliberative Democracy and the Environment* London: Routledge

887

888 Smith, K. A., Brewer, A. J., Crabb, J., and Dauven, A., 2001. A survey of the

889 production and use of animal manures in England and Wales III. cattle manures. *Soil*

890 *Use and Management*. 17, 77-87.

891

892 Stapleton, C. M., Wyer, M. D., Kay, D., Crowther, J., McDonald, A. T., Walters, M.,

893 Gawler, A. and Hindle, T., 2007. Microbial source tracking: a forensic technique for

894 microbial source identification? *Journal of Environmental Monitoring*, 9, 427-439.

895

896 Vinten, A.J.A, Potts, J.M., Avery, L., Strachan, N.J.C., 2009. Microbial pollution of water

897 by livestock: approaches to risk assessment and mitigation. *Animal*, 3, 744-752.

898

899 Veasey, K (2004) *Citizens' Jury Handbook (Update and Revised)*. Minneapolis: the

900 Jefferson Centre:

901

902 Ward, H., Norval, A, Landman, T. and Pretty, J.. 2003. Open Citizens' Juries and the

903 Politics of Sustainability *Political Studies*: 51, 282–299

904

905 Winter, M., Oliver, D. M., Fish, R., Heathwaite, A. L., Chadwick, D. R and Hodgson, C.

906 J., 2011. Catchments, subcatchments and private spaces: scale and process in managing

907 microbial pollution from source to sea. *Environmental Science and Policy*, 14, 315-326

908

909 Wyn-Jones, A. P., Carducci, A., Cook, N., D'agostino, M, Divizia, M., Fleischer, J.,
910 Gantzer, C., Gawler, A., Girones, R., Holler, C., Husman, AMD, Kay, D., Kozyra, I.,
911 Lopez-Pila, J., Muscillo, M., Nascimento, MS, Papageorgiou, G, Rutjes, S., Sellwood, J.,
912 Szewzyk, R and Wyer, M. 2011. Surveillance of adenoviruses and noraviruses in
913 european recreational waters. *Water Research*, 45, 1025-1038.