

1 **A review of evidence on the environmental impact of Ireland's Rural Environment**
2 **Protection Scheme (REPS)**

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17 Key words: REPS, agri-environment, environmental effectiveness, farmland biodiversity,
18 evidence-based policy

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23 **Abstract**

24 Since its inception in 1994, there has been strong demand for evidence of the
25 environmental effectiveness of the Rural Environment Protection Scheme (REPS), which
26 paid farmers in the Republic of Ireland over €3 billion by 2010. A variety of research
27 projects have been undertaken that investigate the environmental effects of REPS through
28 an examination of either specific environmental measures or specific geographical areas. A
29 review of available publications confirmed the absence of a comprehensive, national-scale
30 study of the environmental impacts of REPS. Because of this, there is insufficient evidence
31 with which to judge the environmental effectiveness of the national-scale implementation
32 of the whole scheme. For some specific measures, however, sufficient evidence is available
33 to inform an objective assessment in some cases, and to help learn how to improve
34 environmental effectiveness in most cases. The majority of the REPS payments are now
35 dedicated toward biodiversity objectives. Thus, biodiversity measures and options should
36 be a priority for any national-scale environmental assessment of the scheme. Such a study
37 would help identify the environmental benefits of REPS, the specific elements of REPS
38 that are performing adequately, and those elements that are in need of improvement. Given
39 the considerable overlap between REPS measures and options and those included in the
40 2010 Agri-Environment Options Scheme (AEOS), assessment of REPS measures could
41 also be used to inform the likely environmental performance of the AEOS.

42

43

44 **Introduction**

45 *Background*

46 Agri-environment schemes in the EU are now one of the most important policy
47 mechanisms for the protection of public goods, and offer payments to farmers in return for
48 undertaking management practices (measures) that are intended to maintain, enhance or
49 restore the rural environment. These public goods include clean water, biodiversity, soil
50 quality, aesthetic landscapes, clean air, archaeological heritage, carbon storage, mitigation
51 of extreme weather events, and provision of recreational services (Cooper *et al.* 2009). In
52 the 2007 – 2013 programming period, almost three million farms covering almost 39
53 million hectares across the EU-27 Member States will be supported by agri-environment
54 payments worth €34 billion (including national co-financing) (quoted in Cooper *et al.*
55 2009). Achieving and evaluating the environmental effectiveness of agri-environmental
56 policy is becoming increasingly important in order to satisfy EU agri-environmental
57 legislation, to demonstrate value-for-money to taxpayers, and to avoid accusations of trade
58 distortion (Court of Auditors 2006; Potter and Burney 2002).

59

60 As a formal requirement of the Rural Development Regulation, Member States are obliged
61 to monitor and evaluate the environmental, agricultural and socio-economic impacts of
62 their agri-environment programmes (Article 16, EC Regulation No. 746/96). Summary
63 reports on policy evaluation of agri-environment schemes have concluded that there has
64 been insufficient measurement of their precise environmental outcomes (DG Agriculture
65 2004; European Commission 1998; Oréade-Brèche 2005). In practice, previous evaluation
66 systems have concentrated on administrative issues such as: statements of the aims of the
67 policy programme, the levels of farmer participation, budgetary considerations,
68 administrative structures, the extent of geographical targeting, obligations of participation
69 and the levels of provision and support from extension services (Court of Auditors 2000).
70 However, participation in schemes *per se* does not guarantee the actual delivery of
71 environmental protection or improvement, and only the monitoring of actual performance
72 and environmental outcomes can demonstrate the true value and environmental impacts of
73 agri-environment schemes (Kapos *et al.* 2009; Kleijn and Sutherland 2003; Lee and
74 Bradshaw 1998; McEvoy *et al.* 2006).

75

76 Looking to the near future, a number of different forces are aligning that will likely result
77 in various pressures on the design and budget for the Common Agricultural Policy (CAP),
78 Rural Development Programme and agri-environment schemes. These include an increased
79 number of EU Member States eligible to receive funding from the CAP and Rural
80 Development Programme, increased pressure on EU budgets, and increased pressure on the
81 ability of individual member States to provide co-financing. The European Court of
82 Auditors will report in early 2011 on its audit of the environmental effectiveness of agri-
83 environment schemes. Previous reports from the European Court of Auditors on, for
84 example, Less Favoured Areas (COM 2009b; Court of Auditors 2003), the verifiability of
85 agri-environment schemes (Court of Auditors 2005; 2006) and cross-compliance
86 (European Court of Auditors 2008) have been instrumental in leading to significant
87 changes in policy implementation. The World Trade Organisation (WTO) also requires
88 that the environmental benefits of agri-environmental payments are clearly demonstrated,
89 to ensure that such payments are not disguised trade subsidies. One of the best (if not only)
90 ways to address these various pressures is to quantitatively demonstrate the environmental
91 benefits and value-for-money of agri-environment schemes. This policy context highlights
92 the need for quantitative demonstration of the environmental impact of agri-environment
93 schemes, and why this will become increasingly important.

94

95 *The Rural Environment Protection Scheme (REPS)*

96 The Rural Environment Protection Scheme (REPS) is the agri-environment scheme
97 implemented in the Republic of Ireland. The scheme was initiated in 1994, and is now in
98 its fourth iteration. The stated objectives of REPS have been to:

- 99 • establish farming practices and production methods, which reflect the increasing
100 concern for conservation, landscape protection and wider environmental problems;
- 101 • protect wildlife habitats and endangered species of flora and fauna, and;
- 102 • produce quality food in an extensive and environmentally friendly manner.

103

104 From 2010, the stated objectives of REPS 4 are:

- 105 • To promote:
 - 106 a) Ways of using agricultural land which are compatible with the protection
107 and improvement of the environment, biodiversity, the landscape and its

- 108 features, climate change, natural resources, water quality, the soil and
109 genetic diversity
- 110 b) Environmentally-favourable farming systems.
- 111 c) The conservation of high nature-value farmed environments which are
112 under threat.
- 113 d) The upkeep of historical features on agricultural land.
- 114 e) The use of environmental planning in farming practice.
- 115 • To protect against land abandonment.
- 116 • To sustain the social fabric in rural communities.
- 117 • To contribute to positive environmental management of farmed NATURA
118 2000 sites.
- 119

120 REPS has become a widely adopted scheme (e.g. over 60,000 participants in 2009, Fahey
121 2010), and provides an important financial contribution to farm incomes in Ireland (e.g.
122 McEvoy 1999 and references below). Since 1994, REPS has paid over €3.1 billion to Irish
123 farmers, and about €368 million in 2009 (Fahey 2010). The Teagasc National Farm Survey
124 estimated that 45% of farms received REPS payments in 2008 (Connolly *et al.* 2009), and
125 that average family farm income on REPS farms was €18,339, about 15.5% higher than
126 family farm income of €15,869 on non-REPS farms. About 75% of the farms that
127 participate in REPS are in either the Cattle (Rearing and Other) or Mainly Sheep systems
128 (specific categories in the Teagasc National Farm Survey). In 2008, average family farm
129 incomes on cattle and sheep-dominated farms were higher on REPS farms than non-REPS
130 farms with the REPS payment constituting a substantial proportion of the difference
131 (Connolly *et al.* 2009).

132

133 Since the first official evaluation of REPS in 1999, the absence of both baseline data and
134 the monitoring of biodiversity and landscape measures (DAF 1999, p. 52-53) has been
135 regularly highlighted. Even more recently, a number of reports and documents have had a
136 low incidence of discussion of specific and evidence-based environmental effects of the
137 scheme (AFCon 2003; 2006; DAFF 2007). Nevertheless, since the scheme began, a
138 number of different studies have investigated the environmental effectiveness of REPS. To
139 date, these studies have not been collated or reviewed, which we attempt here. Further
140 justification for this review arises from the considerable overlap and similarity between the

141 existing REPS measures and options and those included in the new Agri-Environment
142 Options Scheme (AEOS) that will replace REPS. Thus, a review of available evidence on
143 the environmental impacts of REPS 3 and REPS 4 is even more relevant as it could be used
144 to more quickly assess the environmental effectiveness of similar measures that are
145 implemented in the AEOS. Similarly, some existing REPS measures or options not
146 included in the AEOS may actually be very beneficial, and evidence for their effectiveness
147 could be used as justification for their inclusion in future agri-environment schemes.

148

149 Here, our primary objective was to collate and review available literature on these studies,
150 with an emphasis on empirical research that is directly relevant to the environmental
151 effects of REPS. The REPS addresses multiple environmental objectives; however, the
152 distribution of payments across those objectives is unequal, and has changed over time.
153 Thus, a secondary objective of this paper was to compare the payment rates of the basic
154 REPS measures and to assess the relative distribution of the payments across different
155 environmental objectives and over time.

156

157 **Expenditure on REPS measures and options**

158 Here, we present the distribution of expenditure across different basic measures and
159 environmental objectives, and how these have changed from REPS 1 to REPS 4.

160

161 Measures 3, 4, 5, 6 and 7 are directly associated with terrestrial and aquatic wildlife
162 habitats, and are based on active management of farmland areas with the aim of protecting
163 or actively enhancing farmland wildlife. The payment for Measure 7 (€8 per hectare) in
164 REPS 4 is justified in Appendix 3 of the Irish Rural Development Plan (DAFF 2007) by
165 the provision of a 20m buffer strip around historic features that is managed “in the interests
166 of biodiversity and landscape”, whereas no such justification was associated with it in
167 REPS 1. At least part of Measures 2, 10 and 11 have direct biodiversity commitments,
168 therefore two-thirds of the payment rate for each of these three measures was estimated to
169 contribute to biodiversity.

170

171 The basic measures of REPS 4 for grassland farmers amount to a total cost of €172 per
172 hectare, which includes a mandatory biodiversity measure (€17/ha). About €137 (79%) is
173 justified through measures directly aimed at farmland wildlife (M3, M4, M5, M6 and M7,
174 and part of each of M2, M10 and M11) (see Table 2). Note that there are also indirect

175 biodiversity objectives associated with Measures 1 and 2 that are not included here in the
176 estimated value of €137. (For completeness, an additional payment for transaction costs
177 brings the total payment for the basic REPS 4 measures to €234/ha.) In REPS 1, a similar
178 approach indicates that about €80 (~57%) of the total payment of €140 was directly aimed
179 at biodiversity objectives. In addition, Measure A pays €282/ha for Natural Heritage Areas
180 and commonages (including Natura 2000 sites, Special Areas of Conservation and Special
181 Protection Areas). In 2007 alone, a total of €56 million was paid for about 337,000 ha that
182 was eligible for Measure A payments (DAFF, 2008), further increasing the total proportion
183 of REPS expenditure that is directly attributable to biodiversity objectives.

184

185 These results show a significant increase between REPS 1 and REPS 4 in the relative
186 proportion of expenditure on biodiversity-related objectives. This is not surprising given
187 that most of the measures associated with the priority objective to protect water quality
188 (largely through improved nutrient management) have since become part of the standards
189 associated with cross-compliance levels, which are no longer paid for. In summary,
190 although different approaches might result in different specific values, these data clearly
191 indicate that the majority of REPS 4 payments is associated with biodiversity objectives,
192 and there has been a considerable increase from REPS 1 to REPS 4 in the proportion of
193 payments that are associated with biodiversity objectives.

194

195 **Environmental performance of REPS: an overview of available evidence**

196 A variety of research projects have been conducted on REPS. These are grouped under the
197 relevant broad environmental objectives as indicated in Table 1, and each of these groups
198 discussed in turn. This list is not intended to be exhaustive, but includes most of the
199 published research studies as well as many of the unpublished ones. (Note that an
200 attempted systematic review with a number of various relevant search terms in Web of
201 Knowledge only resulted in a total of about ten relevant research articles.)

202

203 *Nutrient management*

204 Data from the Teagasc National Farm Survey were used to investigate the financial and
205 physical impact of REPS, through a comparison of REPS (n= 261) and non-REPS farms in
206 1997, as well as a temporal comparison of the same REPS/non-REPS farms in 1997 with
207 their situation in 1994 (before REPS was implemented) (McEvoy 1999). Compared to a
208 group of extensive non-REPS farms, REPS farms had higher investment costs for

209 machinery, buildings and higher maintenance costs for buildings and land. Investment
210 costs associated with the need for compliance with REPS were estimated at £53.7 million,
211 and there were also increased maintenance costs on REPS farms. McEvoy concluded that
212 “REPS farms could be expected to have better pollution control facilities and animal
213 housing, better farm and field boundaries and improved visual appearance of the farm as a
214 result of REPS participation”. Despite a 5% increase in stocking densities on REPS farms
215 from 1994 to 1997 to a level equivalent to that of extensive non-REPS farms, usage of
216 chemical nitrogen and phosphorus was lower on REPS farms by 24 kg ha⁻¹ and 4kg ha⁻¹
217 respectively (see also van Rensburg *et al.* 2009, below). Although there were system-
218 specific effects, the overall expenditure on fertiliser per ha decreased on REPS farms from
219 1994 to 1997. Pesticide expenditure between 1994 and 1997 increased by 2% on REPS
220 tillage farms and by 32% on non-REPS tillage farms. A model-based analysis of National
221 Farm Survey data estimated that the participation of a farm in REPS contributed to average
222 reductions of 29 kg ha⁻¹ yr⁻¹ of nitrogen, 8.3 kg ha⁻¹ yr⁻¹ of phosphorus and 14 kg ha⁻¹ yr⁻¹
223 of methane emissions (Hynes *et al.* 2008b). These data are based on a 10-year period from
224 1995 to 2006. Both the studies by Hynes *et al.* (2008b) and McEvoy (1999) are especially
225 interesting because of their national-scale coverage, their use of a time-series of existing
226 data from the Teagasc National Farm Survey and their methodology to estimate a
227 counterfactual that clearly investigates additionality (what would have happened had REPS
228 not been implemented on farms; Matthews 2002; Finn 2003; 2005).

229

230 A study of animal stocking rates and associated fertiliser inputs in beef suckler systems
231 (Drennan and McGee 2009) also compared nitrate leaching under suckler beef production
232 under management levels comparable to an intensive (~210 kg ha⁻¹ of organic nitrogen)
233 and REPS (~170 kg ha⁻¹ of organic nitrogen) system. Over the three years of the study, the
234 total load of nitrate (NO₃-N) ranged from 15 to 71 kg ha⁻¹ yr⁻¹. Cumulative losses of nitrate
235 over the 3 years (2002-2004) were >50 kg ha⁻¹ yr⁻¹ from the intensive treatment, and <20
236 kg ha⁻¹ yr⁻¹ from the treatment that was representative of a REPS system (Richards *et al.*
237 2007; Richards pers. comm.). Overall, in that study, the performance of individual animals
238 was similar in both systems, indicating that application of fertiliser nitrogen can be
239 substituted with additional land with no negative consequences for individual animal
240 performance (Drennan and McGee 2009).

241

242 REPS plans were examined as part of a project that used participatory approaches to
243 develop agri-environment measures to reduce phosphorous loading from the catchment to
244 Lough Melvin, a candidate SAC with notable fish biodiversity (Doody *et al.* 2009).
245 Participation rates (37%) in REPS in the catchment were substantially lower than those
246 found in the rest of Co. Leitrim (60%), and were considered likely to limit the
247 environmental effectiveness of REPS in the catchment. In the same project, Schulte *et al.*
248 (2009) compared different measures to mitigate phosphorus transport; however, those
249 measures offered by REPS did not include the two that were identified as being most cost-
250 effective and popular in the L. Melvin catchment (feeding of concentrates with low
251 phosphorus concentration, and non-replacement of phosphorus on Index 4 silage areas). Of
252 the measures offered by REPS, none of 55 REPS plans included the REPS supplementary
253 measure for riparian zones. In a participatory consultation with farmers in L. Melvin,
254 Schulte *et al.* (2009) identified both free advisory support and nutrient management
255 planning (NMP) as cost-effective and popular measures. Surveyed REPS participants
256 receive NMP advice in their REPS plan, but some indicated that ‘lack of on-farm support
257 for implementation of their REPS plans’ (Doody *et al.* 2009) may hinder the effectiveness
258 of NMP in REPS.

259
260 The available evidence indicates that REPS is associated with very significant
261 improvements in the management and storage of farm nutrients, which should not be
262 surprising given the scheme’s initial prioritisation of water quality objectives and strong
263 emphasis on nutrient, grassland and agro-chemical management across several REPS
264 measures. Such management on a whole-farm basis appears to have been a specific
265 strength of REPS (which in earlier schemes was paid for but in later schemes has been a
266 requirement of cross-compliance, see above). Note that the detection of improvements in
267 water quality that can be attributed to one policy (especially across multiple farms) is
268 notoriously difficult, and is further complicated by potentially long lag times between
269 changes in management practice and both measurable changes in water quality (e.g. Fenton
270 *et al.* 2010) and ecological recovery of aquatic systems (e.g. Kronvang *et al.* 2005).
271 Overall, however, there appears to have been very significant improvements in
272 management and storage of nutrients and agro-chemicals among REPS farmers, which
273 would be strongly expected to translate into a significant reduction in pressures on water
274 quality.

275

276 *Gaseous emissions*

277 Mitigation of climate change is now an explicit environmental objective of the CAP, and
278 Life Cycle Analysis has been used to compare greenhouse gas emissions from a small
279 sample of REPS and non-REPS farms. For four REPS and six non-REPS farms, Casey and
280 Holden (2005) calculated that milk production on the sampled conventional (non-REPS)
281 farms had about 18% more emissions (kg CO₂ equivalent per kg of energy corrected milk)
282 than that on the sampled REPS farms. Emissions per hectare were 17% greater on the
283 conventional farms, but emissions per unit milk were similar. A similar analysis of beef
284 production compared greenhouse gas emissions (kg CO₂ equivalent per kg of liveweight)
285 from five non-REPS, five REPS and five organic farms (Casey and Holden 2006). On
286 average, emissions per annum or per unit area were highest on the non-REPS farms and
287 lowest on the organic farms, and there was an overall relationship between total emissions
288 per hectare, and intensity of production. Two important caveats arise in relation to both of
289 these studies. First, the quite low sample sizes within each category mean that these results
290 cannot be interpreted as being representative of the national situation. Indeed, the
291 variability within each of these categories is likely to be quite substantial (and well worth
292 future investigation for the identification of farm typologies that may optimise production
293 and environmental quality). Second, assuming that the differences between REPS and non-
294 REPS farms are representative, it is difficult to distinguish between such differences being
295 either caused by the scheme, or reflecting the biased participation of extensive farmers in
296 the scheme. Of course, both these alternatives are not mutually exclusive.

297

298 *Archaeology (measure 7)*

299 REPS has been associated with a beneficial impact on increasing farmer awareness, and
300 formally identifying historical and archaeological features on their land (O'Sullivan 1998;
301 2001; O'Sullivan and Kennedy 1998; Sullivan 2006; Sullivan *et al.* 1999). Sullivan (2006)
302 found that 20% of a sample of 193 features (listed on the National Record of Monuments
303 and Places) were not recorded in the REPS plans. An additional 64 features (not listed on
304 the Record of Monuments and Places) were identified, of which only 11% were recorded
305 in the relevant REPS plans. In light of significant improvements in web-based mapping
306 and REPS planning, one would expect very significant increases in detection and recording
307 in more recent REPS plans, although this has not been verified. Nevertheless, by 1999,
308 none of the archaeological features shown on the Sites and Monuments Record and
309 recorded in the agri-environmental plans on 160 surveyed farms had been destroyed since

310 REPS commenced in 1994 (Sullivan 2006). This was against a background destruction rate
311 of 1.3% recorded between 1996 and 1998 (O'Sullivan and Kennedy 1998). Overall, these
312 studies suggest that this has been an effective measure in improving the protection of
313 archaeological heritage.

314

315 *Designated farmland habitats*

316 Many farmland habitats are designated as Special Protection Areas (SPAs), Special Areas
317 of Conservation (SACs), Natural Heritage Areas (NHAs) or commonage. If so, they are
318 eligible for additional payment under REPS Measure A.

319

320 Commonages are typically areas of high conservation value and account for about 90% of
321 SACs, 10% of SPAs, and 60% of Natural Heritage Areas (van Rensburg *et al.* 2009),
322 making them highly relevant to agri-environment policy aims to halt biodiversity loss. A
323 sample of 282 commonage farmers (193 in REPS) in Counties Galway and Mayo were
324 surveyed by interview in 2004. Two aims of that study were to investigate whether
325 participation in REPS has changed either farm management or farmers' environmental
326 awareness. On average, REPS farms spent 43% less on chemical fertiliser than non-REPS
327 farms. Stocking rates on non-REPS farms were 0.54 livestock units (LU) ha⁻¹ and 0.43 LU
328 ha⁻¹ on REPS farms; 81% of non-REPS farms were obliged to reducing stocking densities
329 in their Commonage Framework Plans, as opposed to 56% of REPS farms. The latter was
330 attributed to a combination of the REPS management plan and the potential bias for farms
331 with lower stocking densities to preferentially enter REPS. There was evidence of a greater
332 level of environmental awareness among the commonage farmers in REPS, although the
333 magnitude of this was small, and absolute levels of awareness in the sample of farmers
334 were considered to be low (van Rensburg *et al.* 2009).

335

336 As a case study of a Measure A habitat, undergrazing and scrub encroachment were
337 identified as severe and widespread threats in the Burren (Dunford and Feehan 2001, see
338 also Parr *et al.* 2006, 2009). Several reports suggest that such threats have not been
339 adequately addressed by REPS (Williams *et al.* 2009, Walsh 2009). In response to this
340 need, since May 2010 there is a dedicated Burren Farming for Conservation Programme
341 (BFCP) (DAFF 2010) to protect and enhance species-rich grasslands and water quality,
342 based on lessons learned from the BurrenLIFE project (Williams *et al.* 2009; Walsh 2009).

343

344 Turloughs are a priority habitat in Ireland. In a survey of 42 farmers with turloughs on their
345 land, thirteen were participants in REPS in 2002 (Moran *et al.* 2008). After joining REPS,
346 six of these REPS participants changed management, and had ceased fertiliser application
347 (n=4), ceased silage cutting (n=1) or reduced grazing periods (n=2) on the turlough land,
348 all of which would be expected to improve the management of these turloughs for
349 biodiversity. Moran *et al.* (2008) pointed out that the low participation rate of turlough
350 owners currently limits the potential of REPS to improve turloughs in general. (The study
351 did not directly compare the management practices or ecological status of the turlough
352 areas enrolled in REPS with those not in REPS.)

353

354 One of the stated main objectives of REPS has been to “...protect ... endangered species
355 of flora and fauna”. To date, there have been very few dedicated management prescriptions
356 that are directly aimed at protecting named endangered species (as opposed to habitats).
357 REPS does make specific mention of salmonids, crayfish (*Austropotamobius pallipes*),
358 owls, corncrake (*Crex crex*), rare domestic animal breeds, rare apple varieties and possibly
359 bats and the freshwater pearl mussel (*Margaritifera margaritifera*), but the effects of some
360 of these supplementary measures and options must be low to negligible given both the very
361 low participation rates (DAFF 2009) and the non-specific nature of some of the
362 management prescriptions. Note, however, that these protected species may have benefited
363 from some other REPS measures e.g. protected aquatic species may have benefited from
364 general measures aimed at improved nutrient management and water quality.

365

366 Although there have been many projects and publications that are relevant to designated
367 habitats, very few have specifically addressed the environmental impact of REPS on such
368 habitats. A recent report by the National Parks and Wildlife Service (NPWS 2008) on the
369 status of protected habitats and species in Ireland highlighted the frequent ‘bad’
370 conservation status associated with agricultural habitats. The report did not distinguish
371 between habitats that occurred on REPS or non-REPS farms. The NPWS is responsible for
372 management guidelines for all such designated habitats, so in the absence of contradictory
373 evidence there is no strong reason to believe that designated habitats on REPS farms were,
374 on average, in better condition than designated habitats on non-REPS farms. This would be
375 very interesting to investigate, and some case studies (Moran *et al.* 2008; van Rensburg *et al.*
376 *et al.* 2009) tentatively suggest the possibility that REPS participants may implement better

377 management of designated habitats than non-REPS participants, although this improved
378 management may not necessarily be sufficient to attain favourable conservation status.

379

380 *Non-designated farmland habitats*

381 Measure 4 of REPS aims to protect farmland habitats that do not have a formal designation
382 for biodiversity protection (e.g. farmland habitats that are not in a Special Protection Area,
383 Special Area of Conservation or Natural Heritage Area), and this represents a very
384 important policy instrument to protect farmland biodiversity. This measure aims to include
385 a very wide range of habitats, and grasslands “with less than 25% of ryegrass, timothy,
386 white clover either individually or in combination” (REPS planner specifications). Most
387 studies of habitats in REPS refer to the need for more conservation and ecological advice
388 for REPS farmers and REPS planners, with the aim of improving the identification and
389 appropriate management of habitats (see Table 1).

390

391 In a DAF survey of REPS planners, only 25% believed that Measure 4 was effective (DAF
392 1999). Bohnsack and Carrucan (1999) found that habitats identified by them on a small
393 sample of REPS farms in Co. Clare were not recorded in the REPS plans. In a report on
394 monitoring of the environmental effectiveness of REPS, An Taisce (2002) surveyed 20
395 REPS farmers and 20 REPS planners and found strong support among them for more
396 ecological expertise, and recommended “more emphasis on the integration of ecological
397 considerations into REPS planner training”. A survey in Co. Galway highlighted a lack of
398 awareness regarding farmland habitats among REPS 1 farmers (n = 32), and inadequate
399 information on habitat identification and management in the REPS specifications
400 (Aughney and Gormally 2002).

401

402 A survey of 50 REPS 1 plans in Co. Roscommon found that over 70% of the farms had no
403 habitats, which the authors commented on as ‘not representative of the Roscommon
404 countryside’ (Curtin and Whelan 1998). A separate DAF (1999) analysis of 1% of REPS
405 plans showed that no habitats were recorded on 39% of farms, but found an overall average
406 of 1.6 habitats per farm (covering 4ha). The complete absence of habitats both in the
407 majority of farms in the Roscommon sample and in many farms in the DAF study is very
408 surprising given the frequency of habitats found in other studies of Irish farmland (e.g.
409 Purvis *et al.* 2009a; Sullivan *et al.* in press; see below). This strongly suggests a non-
410 standard methodology for the identification and/or recording of habitats in the former

411 studies. Clarke (1998) interviewed REPS farmers in County Louth after four years of
412 participation in REPS, and found an average of 1.55 habitats per farm. A survey of 32
413 farms in east Galway (outside of SAC areas) recorded an average of 2.6 semi-natural
414 habitats per farm, with an average area of 15.2% of the farm (Sullivan 2010; Sullivan *et al.*
415 2011); only three farms had no semi-natural habitats and >40% of the farms had three or
416 more semi-natural habitats. An ecological survey of 19 REPS demonstration farms found
417 that most of the farms contained at least 5 common farmland habitats (average = 7),
418 although the survey data were not intended for quantitative analysis (Gabbett and Finn
419 2005) and there was no comparison with the habitat records on the corresponding REPS
420 plans. An accompanying attitude survey (Gabbett and Finn 2005) found that most of the
421 surveyed REPS demonstration farmers and associated planners/advisors believed that there
422 was a need for improved provision of information about identity and management of
423 farmland habitats and wildlife in REPS.

424

425 The Ag-Biota project surveyed habitats on 50 farms in the south-east of Ireland (Purvis *et*
426 *al.* 2009a). Thirteen of the farms were participating in REPS, and REPS status was
427 included as a variable in a multivariate analysis of habitats. Participation in REPS was not
428 significantly associated with a number of descriptors of farm habitats, with the exception
429 of a significant association with the proportion of field boundary habitats on the farm. Note
430 that an analysis of the effect of REPS was not an original hypothesis of the work, and the
431 number of REPS farms was relatively low in the study.

432

433 In one of the few large field-based research projects on REPS, the Farmland Birds Project
434 used birds as indicators in an ecological monitoring methodology for the REPS, to
435 determine current impacts of REPS on biodiversity, and to offer research-based
436 recommendations to improve REPS (Copland and O'Halloran 2010). A total of 122 farms
437 were surveyed from 2003-2005, and consisted of 61 REPS farms and 61 non-REPS farms
438 distributed across the north-west, midlands and south-east of Ireland. At each farm,
439 information was collected on birds, farmland habitats, and field boundaries. Overall, there
440 was no significant difference in either bird diversity or abundance between REPS and non-
441 REPS farms. In addition, no significant differences occurred in the mean density of
442 different types of field boundary or in the overall proportion of various farmland habitats.
443 Some differences in specific habitat types were identified, and REPS farms had a greater
444 density of hedgerows and a greater amount of some other habitats (stubbles, rough

445 vegetation) than non-REPS farms (Copland 2009). Since the Farmland Birds Project
446 completed its survey, REPS 4 has introduced some new options that may benefit bird
447 biodiversity, but the effectiveness of these has not yet been assessed.

448

449 Data from both the Irish Census of Agriculture and National Farm Survey were analysed to
450 estimate the probability of participation in REPS of broad habitat types for which data was
451 available from the habitat data of the FIPS-IFS project (Hynes *et al.* 2008a). Farmland with
452 wet grassland, peatland, rocky complexes, forest and shallow water habitats was more
453 likely to be enrolled in REPS than farmland with heath, dry grassland, built land and cut
454 fen. Note, however that the spatial resolution of the habitat data was quite coarse (based on
455 point descriptions of habitats on a 10 km grid), and it was beyond the scope of that study to
456 collect evidence with which to assess whether enrolment in REPS had afforded protection
457 and proper management to habitats.

458

459 Field margins are a type of non-designated habitat that are prominent within REPS, and
460 have been the subject of several dedicated research projects. The creation and protection of
461 field margins in arable systems has been well documented to benefit farmland wildlife
462 (Marshall and Moonen 2002). In contrast to arable systems, the protection of field margins
463 in grasslands is relatively recent, and far less experimental evidence is available. Feehan *et*
464 *al.* (2005) compared plant and insect diversity of watercourse and field margins in
465 grassland (n=30) and mixed tillage (n=30) using paired samples of REPS and non-REPS
466 farms. The comparison (in grassland and tillage systems) generally indicated no positive
467 impact of REPS on the species richness of either carabid beetles or plants. In that study,
468 note that although the reporting of the analysis of plant species richness in grassland
469 margins on REPS (12.5 ± 3.3) and non-REPS (14.2 ± 3.5) farms indicated a significant
470 difference, the size of the error estimates make this seem unlikely; in any event, the
471 magnitude of the difference was not large. Feehan *et al.* (2005) recommended a minimum
472 field margin width of 3m in both arable and grassland field margins; the width of 1.5m in
473 REPS would be significantly narrower than usual (e.g. Marshall and Moonen 2002). An
474 experimental study of field margins on a single REPS farm in Co. Longford found that
475 plant species richness was increased (although only modestly) over a two-year period when
476 nutrients were excluded (Sheridan *et al.* 2009). Invertebrate abundance in emergence traps
477 was higher in field margin areas than in the main sward of the field. In the same study,
478 there was no significant difference in either plant diversity or overall invertebrate

479 abundance between the grazed field margin (representative of REPS situation) and the
480 1.5m ungrazed experimental field margin, which is likely to reflect the relatively short
481 duration of the study. That study also documented successful efforts to control bracken in
482 the experimental field margins. In another experimental study aimed at informing the
483 management by REPS of grassland field margins, different establishment and management
484 strategies of field margins had significantly different effects on plant and insect diversity
485 over a two-year period (Sheridan *et al.* 2008). That work showed that reseeded with a
486 diverse mixture of grass and wildflowers could successfully result in more diverse
487 vegetation in new experimental field margins in dairy systems, and that cessation of
488 fertiliser inputs alone was ineffective in increasing vegetation diversity. More recent
489 research on these same plots confirmed long-term positive effects of the reseeded
490 treatment on plant and invertebrate diversity (Fritch *et al.* 2009, 2011). A large body of
491 international research suggests that properly managed field margin habitats can be a
492 significant reservoir of farmland wildlife and biodiversity (e.g. Asteraki *et al.* 1995;
493 Douglas *et al.* 2009; Marshall and Arnold 1995; Marshall and Moonen 2002; Meek *et al.*
494 2002; Woodcock *et al.* 2005). Unfortunately, however, the current REPS management
495 prescriptions for grassland field margins are highly unlikely to deliver plant and
496 invertebrate diversity, especially in more intensively managed grasslands. Cessation of
497 nutrient inputs alone is not likely to significantly increase the conservation value of margin
498 vegetation in such areas, and invertebrates and ground-dwelling wildlife are less able to
499 utilise margins that are persistently grazed to a low sward height (Bakker and Berendse
500 1999; Bokenstrand *et al.* 2004; Marshall and Moonen 2002; Woodcock *et al.* 2005).

501

502 Measure 5 of REPS aims to protect and maintain farm and field boundaries, and hedgerow
503 management has featured prominently in REPS. Hedgerows are one of the most abundant
504 field boundary types in Ireland, so this measure is widely implemented. As optional
505 measures, hedgerow rejuvenation and establishment have also been extremely popular
506 (DAFF, 2009). Unsurprisingly Copland *et al.* (2005) found that REPS farms had a greater
507 density of hedgerows than non-REPS farms. Despite being included in REPS since its
508 inception, however, relatively little evidence exists on the specific environmental impact
509 on biodiversity due to the management and/or creation of hedgerows by REPS. A doctoral
510 study by Flynn (2002) found no significant difference in the average number of bird
511 species or the density of birds recorded on REPS and non-REPS farms. That study found
512 that REPS hedgerows had significantly higher botanical species richness than non-REPS

513 hedgerows. Overall, the number of farms in the study design was too low (five REPS and
514 five non-REPS farms) to make any general conclusions. In a relatively large study, the
515 Farmland Birds Project found no difference in bird densities between REPS and non-REPS
516 farms, and concluded that “field boundary management in REPS has little impact on bird
517 populations” (Copland and O'Halloran 2010).

518

519 Generally, a variety of studies have suggested concerns with the identification and proper
520 management of non-designated farmland habitats identified under Measure 4 (Table 1).
521 Note that these studies were generally from the earlier REPS schemes, and the situation
522 may have improved over time (although this is not clear). It is advisable to be cautious
523 about over-extrapolating to the national implementation of REPS from areas and surveys
524 that are not nationally representative, have low sample sizes and do not include random
525 sampling in the selection of farms. Many of the studies cited here have not been published
526 in journals, and (as often occurs in, for example, conference abstracts or short papers)
527 lacked a formal description of both the methodology for farm selection and the definition
528 of habitat types, which hinders comparison across studies. Even if there have been failures
529 to properly document habitats in REPS plans, habitats may well continue to be maintained
530 (although it would reduce confidence in the capacity of the scheme to formally protect
531 such habitats). Overall, these studies on non-designated habitats suggest that a high priority
532 for research is to establish the role of REPS 3 and 4 in protecting and conserving non-
533 designated farmland habitats, and in establishing the extent to which measures exceed the
534 requirements of cross-compliance. This could be achieved in a representative sample of
535 REPS plans, for example, by a comparison of habitats in a farm-scale habitat survey with
536 the habitat records in the corresponding REPS plans, as well as a comparison of habitat
537 diversity, habitat quality and the rate of habitat modification/removal on REPS and non-
538 REPS farms (within similar farming systems and regions). The latter would require
539 baseline data to facilitate a comparison over time, and may still be possible *via* the use of
540 satellite imagery or aerial photography.

541

542 *Studies of multiple environmental objectives*

543 In a wide-ranging analysis of REPS farms on the Aran Islands, Kelly (2008) emphasised
544 the high ecological and heritage value of the area, and pointed to the lack of applicability
545 there of many REPS measures or options. A 2007 survey of 211 REPS plans (REPS 2 and
546 3) identified farm characteristics, management obligations and chosen measures/options.

547 Questionnaire responses by 40 farmers indicated a lack of understanding of the variety and
548 nature of wildlife habitats on their farms and, for example, they did not consider stone
549 walls, field margins and species-rich grasslands to be habitats (*loc. cit.* p. 85).
550 Respondents' knowledge of both archaeology and farmland habitats was considered
551 unsatisfactory. The respondents also indicated alternative measures that would benefit the
552 Aran Islands in the future (p. 76), with control of brambles, scrub and ferns as well as
553 access to monuments being most frequently chosen. The study highlighted problems with
554 scrub invasion. Overall, the respondents considered that REPS had benefited the Aran
555 Islands. The study concluded by emphasising the need for a more targeted measure or
556 scheme to better reflect the conservation priorities there (see also The Heritage Council
557 2010).

558

559 As part of the EU FP6 ITAES project (Integrated Tools to design and implement Agro
560 Environmental Schemes), a multicriteria methodology was used to estimate the
561 environmental effectiveness of an agri-environment scheme in each of two study areas:
562 Ireland (REPS 2) and the Emilia-Romagna region of Italy. The environmental indicators
563 used were based only on information from the mid-term evaluation (2003/2004) of the
564 Rural Development Programmes (2000-2006). The results suggested that both schemes
565 only partially achieved their objectives. This conclusion was tentative, however, due to the
566 scarcity of quantitative data that related to effectiveness, the lack of quantitative target
567 levels for objectives, and difficulties in determining the relative importance of different
568 environmental objectives (Bartolini *et al.* 2005; Viaggi *et al.* in press).

569

570 Largely due to the absence of sufficient quantitative data with which to assess the
571 environmental effectiveness of schemes in the participating countries (including REPS, see
572 Viaggi *et al.* in press), the ITAES project also developed a methodology to estimate the
573 environmental performance of these selected schemes. This methodology largely relied on
574 expert panels to assess the link between environmental measures and the environmental
575 objectives by scoring a set of specific criteria that reflect important factors for the delivery
576 of environmental benefits (Finn *et al.* 2007; Finn *et al.* 2008a). In general, experts
577 indicated that the objectives and targets of the REPS 2 scheme and its measures were
578 neither sufficiently defined nor easily translated into quantifiable targets against which to
579 monitor progress. Scores for farmer compliance were consistently high (indicating high
580 compliance), whereas scores for targeting and participation were often low. The scores for

581 causality and institutional implementation showed much greater variation (Finn *et al.*
582 2007). Measures 3, 6 and 9 of REPS 2 received the lowest effectiveness scores, largely due
583 to the narrow width of the protective strips for these measures. The best-performing
584 measures were considered to be Measures 1, 2 and 7 and Supplementary Measures 3
585 (Conservation of Animal Genetic Resources), 4 (Long-term Riparian Zones) and 6
586 (Organic Farming). Even the latter measures had geometric means of about 3.5 (out of 5),
587 which implied that they either had consistent moderate deficiencies across the effectiveness
588 criteria or severe deficiencies in some of the criteria. Despite an explicit objective of REPS
589 to "...protect ... endangered species of flora and fauna" the experts also indicated that the
590 scheme did not sufficiently target named species (rather than habitats) in need of protection
591 (with the sole exception of the corncrake). This did not necessarily mean that REPS 2
592 made no contribution to species in need of protection, but that the experts considered that
593 the scheme design and implementation did not explicitly or sufficiently target this
594 objective. Overall, the experts agreed that REPS has strongly contributed to an
595 improvement in nutrient management and water quality and they specifically cited the
596 reductions in stocking density on many commonages as a general success; however, the
597 experts had mixed views about the role of REPS in protecting or enhancing farmland
598 biodiversity. Further analysis of several EU case studies that included REPS in Ireland
599 (Finn *et al.* 2009) also showed that higher priority environmental objectives (as assessed by
600 stakeholders) were not necessarily associated with higher estimates of environmental
601 effectiveness.

602

603 A complementary study (Carlin *et al.* 2010) also used experts' judgements to assess the
604 options and supplementary measures associated with REPS 4, and ranked them in order of
605 estimated effectiveness. The experts' assessment indicated that in most (but not all) cases,
606 correct implementation of the management prescriptions is expected to achieve the
607 environmental objective (valid cause-and-effect model), and prescriptions are expected to
608 be implemented correctly (compliance). Several measures/options were expected to
609 achieve little or no benefit for biodiversity. Several of those had too little participation to
610 be effective, but some were associated with medium to very high participation levels. The
611 experts recommended the use of a tiered approach, with the choice of options being
612 strongly guided toward the environmental objectives that were most appropriate to the
613 specific conditions on a farm (see also the example of riparian zones from Doody *et al.*
614 2009).

615

616 The EU FP6 Agri-Environmental Footprint (AE-Footprint) project developed methodology
617 to assess the environmental effectiveness of agri-environment schemes with multiple
618 environmental objectives (Purvis *et al.* 2009b). The AE-Footprint Index (AFI) is a
619 weighted sum of agri-environmental indicators of environmental quality of farms on a
620 standardised scale from 0 (low environmental performance) to 10 (high environmental
621 performance). As a proof-of-concept application, data were collected for indicators for a
622 small number of REPS and non-REPS farms in Sligo and Cork (Finn *et al.* 2008b). The
623 environmental criteria used went beyond those based on REPS, to measure the wider
624 environmental impact of the scheme. In the application of the methodology in Sligo, the
625 mean AFI score of the REPS farms (5.74, n = 10) was significantly ($p=0.05$) higher than
626 that of the non-REPS farms (5.00, n = 10). In the application of the AFI in Cork, the mean
627 AFI scores of the REPS farms (4.72, n = 8) was about 25% greater than the mean AFI
628 score (3.78, n = 8) of the non-REPS farms (Finn *et al.* 2008b). The interpretation of the
629 lower scores in Cork requires considerable care due to the fact that the spatial location of
630 the REPS farms did not overlap with that of the non-REPS farms, and the use of two
631 slightly different forms of the AFI (weighting and indicators differed) between Cork and
632 Sligo. Overall, great care is required in interpreting these comparisons of REPS and non-
633 REPS farms. This study was conducted as a proof-of-concept and had very low sample
634 sizes; coupled with the restricted geographical distribution of the study, these data are
635 certainly not representative of the national REPS scheme.

636

637 *Other topics*

638 For selected EU agri-environment schemes (including REPS), Primdahl *et al.* (2010)
639 distinguished among three categories of impact models (quantitative, qualitative or
640 common sense), depending on the degree of evidence provided about the relationship
641 between the objectives and impacts of each agri-environment scheme. The environmental
642 indicators associated with each scheme were categorised as uptake, performance or
643 outcome indicators. By far the most common type of indicator recorded was found to be
644 'uptake'. This could be seen as a useful indicator of policy effects provided that well-
645 developed impact models existed, but the analysis clearly indicated that this was most
646 often not the case, as just over half of the 180 uptake indicators were linked to common
647 sense impact models. Schemes that explicitly targeted either particular parts of individual
648 farms or specific areas tended to be based more on quantitative impact models than whole-

649 farm schemes or broad, horizontal schemes. They concluded that a high number of the
650 schemes studied were not well designed to enable appropriate evaluation, which hinders
651 efforts to learn how to improve the schemes.

652

653 The ‘Others’ section at the end of Table 1 presents a number of other publications that
654 address a variety of issues, including landscape preferences, economic commentaries and
655 general critiques.

656

657 **Main outcomes**

658 An increasing number of studies are available with which to learn about the actual or likely
659 environmental effectiveness of REPS. A considerable proportion of these studies has not
660 been published in international journals, and is only available as national reports, theses,
661 conference papers and conference abstracts. Compared to the high standard of evidence
662 associated with journal articles, care is required in the interpretation of evidence from other
663 sources (although some of this is of a very high standard).

664

665 On the basis of these studies and publications, a number of conclusions arise that are
666 relevant to institutional efforts to assess the environmental impacts of REPS, as follows:

- 667 • There is insufficient evidence with which to judge the environmental effectiveness
668 of the national-scale implementation of the whole Rural Environment Protection
669 Scheme. This makes it equally likely that the full benefits of the scheme have not
670 been measured, as well as reducing the opportunity to learn how to improve it.
- 671 • Some individual studies provide evidence to scientifically assess the environmental
672 effect of individual REPS measures; however, most studies lacked national-scale
673 coverage.
- 674 • There is a distinct lack of studies that use baseline data to compare change over
675 time (longitudinal studies).
- 676 • Of the studies undertaken to date, there has been an emphasis on biodiversity
677 studies, but these have had little or no co-ordination in their aims, methods,
678 temporal scales or spatial scales.
- 679 • There have been surprisingly few studies on the impact of REPS on nutrient
680 management and water quality, but the available evidence is generally positive.

- 681 • A considerable number of studies have investigated the environmental effects of
682 REPS, although relatively few of these have been published in journals.
- 683 • Some evidence currently exists to guide advice/recommendations about the
684 environmental effectiveness of REPS.

685

686 A primary conclusion of this review is that there is insufficient evidence with which to
687 judge the environmental impacts of the national-scale implementation of the whole Rural
688 Environment Protection Scheme. It is important to note that this does not necessarily mean
689 that REPS has not delivered environmental benefits, but that there has been insufficient
690 collection of evidence of the environmental performance of the whole REPS programme.
691 Thus, the full benefits of the scheme have not been measured, and there has been reduced
692 opportunity to learn how to improve the scheme. The REPS consists of multiple measures,
693 supplementary measures and (since REPS 3) a variety of options. For many of the newer
694 supplementary measures and options that have been introduced since REPS 3, no empirical
695 evidence is available with which to judge their environmental effects, which hinders an
696 overall assessment of the whole scheme. For several other individual elements of REPS,
697 however, sufficient evidence is available with which to either objectively assess their
698 environmental impact or to learn how to improve their environmental effect (as reviewed
699 above). Note, however, that the environmental impact of REPS may be more than the sum
700 of the impacts of the measures. For example, synergistic environmental effects may arise
701 from the ‘bundling’ of several different measures within fields or farms (but would be
702 difficult to detect). As another example, the economic benefit of the REPS payment has
703 almost undoubtedly been to maintain farm structures and farming in places where
704 intensification or abandonment might otherwise have occurred.

705

706 To date, there has not been a comprehensive, national-scale study of the environmental
707 impacts of REPS and the various studies reviewed here, either individually or in aggregate,
708 do not (and could not be expected to) fulfil this function. Finn (2010) recently conducted a
709 scoping study to identify the environmental aims, sampling regime and estimate of costs
710 for a monitoring programme for REPS. To reduce the costs of a monitoring programme, a
711 subset of measures were selected on the basis of participation levels, budget share and
712 environmental priority. Given that the majority of the funding has been allocated to
713 biodiversity measures, the majority of the monitoring effort should also be dedicated to

714 biodiversity. (Note that several of the measures for water quality and mitigation of climate
715 change are also strongly linked to biodiversity measures.) The average annual budget for
716 environmental monitoring of the selected measures (~€0.86m) was estimated to be about
717 0.25% of recent annual expenditure on REPS (e.g. €368m in 2009) (Finn 2010).

718

719 **Lessons learned and future prospects**

720 The absence of a systematic, national-scale environmental monitoring programme clearly
721 limits the *ex post* evaluation of the environmental effect of REPS (see above). The
722 importance of the design stage of schemes (and their *ex ante* evaluation) was emphasised
723 by Finn *et al.* (2009, p. 735), “Ideally, monitoring and evaluation should aim to confirm the
724 good environmental performance of well-designed schemes, rather than highlight
725 weaknesses due to poorly designed ones. Inadequate design of agri-environment schemes
726 can lead to poor environmental performance that can take a significant duration to correct.”
727 Some specific suggestions to improve design are relevant to REPS (Finn *et al.* 2008a;
728 2009; Primdahl *et al.* 2010). If, as seems likely (see below), future agri-environment
729 schemes will incorporate more specific objectives and spatial targeting, there is likely to be
730 an increased reliance on research to inform the evidence base for policy design, *ex ante*
731 evaluation and *ex post* evaluation. In addition to the outputs from specific projects, this
732 review points to the research capacity that exists to conduct such research. Several of the
733 reviewed studies are noteworthy for their methodologies. In addition to the various
734 surveys, these include, for example, the use of participatory approaches (Doody *et al.*
735 2009; Purvis *et al.* 2009b), experts’ judgements (Finn *et al.* 2009; Carlin *et al.* 2010),
736 combined agronomic and economic analysis of alternative agri-environment measures
737 (Schulte *et al.* 2009), field experiments (Richards *et al.* 2007; Fritch *et al.* 2009, 2011;
738 Sheridan *et al.* 2009; Moran 2009), analysis and modelling of existing data (including GIS
739 approaches and National Farm Survey data) (McEvoy 1999; Bartolini *et al.* 2005; Casey
740 and Holden 2005; 2006; Hynes *et al.* 2008a; 2008b), use of the eREPS database (Kelly
741 2008), and relatively large monitoring studies directed at specific REPS objectives
742 (Dunford and Feehan 2001; O’Sullivan 2001; Aughney and Gormally 2002; Feehan *et al.*
743 2005; Sullivan 2005; van Rensburg *et al.* 2009; Copland and O’Halloran 2010).

744

745 Considerable anecdotal comment highlights a success of REPS as being its role in
746 reinforcing existing positive practices, as well as transforming farmers’ attitudes and
747 helping to incorporate environmental awareness and actions into farming practice. All

748 REPS participants attend a 20-hour training course on the environmental objectives of
749 REPS, and this course would be expected to significantly increase the environmental
750 awareness of participants. Unfortunately, there is relatively little published evidence in
751 recent years to specifically validate this claim (but see work by Costello 2003; Hyde 2003;
752 Kelly 2008; van Rensburg *et al.* 2009), and future studies should distinguish among
753 awareness levels of different environmental objectives (e.g. cross-compliance, common
754 habitats, priority habitats, fertiliser use, nutrient storage etc.). The long-term impacts of
755 REPS on farmers' behaviour are even more unclear. Over the next few years, some
756 participants in REPS will enter new contracts, but due to a reduction in budget and
757 consequent restrictions on participation, many participants will conclude their contract and
758 no longer participate in an agri-environment scheme (or will participate in a less
759 demanding scheme). This raises several questions. Will the conditions of re-entry to a new
760 scheme with limited budget and participation successfully target those farms that offer
761 greatest environmental benefit? For farmers who will no longer participate in an agri-
762 environment scheme, to what extent will they retain elements of farming practice that were
763 learned in REPS and go beyond the requirements of cross-compliance? What will be the
764 fate of environmental benefits that have been gained? Will management of farmland
765 habitats change, and what will be the consequences for habitat quality and biodiversity?
766 Answering such questions would involve its own dedicated monitoring programme, but
767 would give insight into the long-term value of agri-environment schemes, both in
768 protecting environmental capital but also in positively influencing farmer behaviour
769 through improved awareness (Stobbelaar *et al.* 2009).

770

771 As is the case with many such studies that compare participating and non-participating
772 farms in voluntary agri-environment schemes, there is a likely bias of higher participation
773 rates of farms with higher levels of environmental quality (because they have lower costs
774 in attaining the required environmental standards) (Matthews 2002; Quill rou and Fraser
775 2010). One of the best measures of the environmental effectiveness of a scheme would be a
776 comparison of the change in environmental state before and after policy implementation,
777 and on participating and non-participating farms (Bro *et al.* 2004; Finn 2003; Finn *et al.*
778 2008a). For these reasons, the collection of baseline data is an important contributor to an
779 effective monitoring programme. Given the absence of dedicated baseline surveys in
780 REPS, the data and sites from earlier studies provide a potential baseline of environmental
781 status. By conducting future surveys in the same locations, changes in environmental status

782 (due to REPS participation) may be assessed. Unfortunately, most studies cannot be
783 repeated on the original sites because they do not contain information on the geographical
784 location of the farm or the sampling site within the farm. Where possible, it is desirable
785 that in future agri-environmental surveys, agreements are reached with farmers
786 participating in a survey that allow researchers to enquire about farmers' willingness to
787 participate in a future re-survey. In addition, data should be provided in a GIS format that
788 is linked to the spatial location of sites.

789

790 A number of studies draw attention to, or provide examples of, the need for sufficient
791 participation to achieve intended environmental objectives (Moran *et al.* 2008; Finn *et al.*
792 2007; 2008a; 2009; Doody *et al.* 2009; Finn 2010; Carlin *et al.* 2010). A key challenge for
793 the future will be to gain a more detailed understanding of how participation (uptake) is
794 quantitatively related to achievement of environmental objectives, and to improve our
795 knowledge of the minimum participation rates to ensure sufficient supply of a desired
796 environmental good. This would help ensure that limited funds do not continue to be
797 allocated to measures for which there is already sufficient participation; nevertheless many
798 public goods are far more likely to remain at risk of under-supply rather than over-supply.
799 (To complicate matters, the relationship between participation and environmental supply
800 may not be linear (Wu and Skelton-Groth 2002, Finn *et al.* 2008a)).

801

802 *Biodiversity, agri-environment schemes and the post-2013 CAP*

803 The significant role of biodiversity as a high priority objective that is associated with the
804 majority of REPS expenditure warrants further treatment. The specific policy mechanisms
805 and budget size for provision of public goods in the post-2013 CAP are not yet certain at
806 either national or EU levels. Nevertheless, the provision of environmental and other public
807 goods is very likely to be of central importance in the post-2013 CAP (see below),
808 especially as most public goods from agriculture are threatened but remain highly valued
809 by society (MacDonald *et al.* 2000; Cooper *et al.* 2009). The post-2013 CAP, however, is
810 almost certain to require improved specification of policy targets, a greater level of
811 geographical targeting, improved implementation and a stronger requirement for
812 monitoring and evaluation (Court of Auditors 2006; Cooper *et al.* 2009). These
813 requirements will also be expected of agri-environment schemes, and represent key
814 challenges for policy design, targeting of financial support to where it can achieve most
815 environmental impact, and delivery of farm-level environmental advice.

816

817 Biodiversity will continue to be a key EU-level objective for agri-environment schemes.
818 As contracting parties to the UN Convention on Biological Diversity, the EU has been
819 committed to halting biodiversity loss by 2010. However, recent assessments indicate that
820 this 2010 target has not been met (CEC 2008; COM 2009a), and the EU is now preparing
821 to strengthen its policy framework and commitment to halting the loss of biodiversity and
822 the degradation of ecosystem services in the EU by 2020, and restoring them in so far as
823 possible (Council of the European Union 2010). Thus, it would seem that the success of
824 biodiversity measures in agri-environment schemes will increasingly be judged by the
825 extent to which they halt (and/or reverse) the loss of biodiversity (and related ecosystem
826 services). Specific biodiversity objectives in Irish agri-environment schemes might be
827 expected to reflect national policy priorities as reflected in, for example, Ireland's National
828 Biodiversity Plan (DAHGI 2002) and the National Strategy for Plant Conservation
829 (National Botanic Gardens 2005). A recent assessment of the conservation status of
830 priority habitats and species found many of those associated with farmland to be in poor or
831 bad condition (NPWS 2008), and these are an obvious priority for strengthened
832 biodiversity measures in REPS (or future agri-environment schemes). As with most
833 countries, Ireland has a significant number of Red Data Book species, some of which have
834 Species Action Plans. The targeting of biodiversity measures toward Red Data Book
835 species (and their habitats), for example, would be expected to strongly address the
836 objective of halting biodiversity loss.

837

838 In the new monitoring and reporting structure for the Rural Development Programme, the
839 seven impact indicators of the Common Monitoring and Evaluation Framework (European
840 Commission, 2006) include the Farmland Birds Indicator and the High Nature Value
841 Indicator (Beaufoy 2008; Beaufoy and Cooper 2009). In relation to farmland birds, there
842 are 24 bird species on the Irish Red List (Birdwatch Ireland 2010). At least eleven of the 24
843 species on the current Red List are considered to be farmland or commonage species, and
844 others are on the Amber and Green Lists (Birdwatch Ireland 2010). Member States were
845 required to identify High Nature Value farmland by 2006, and target agri-environmental
846 payments to those areas by 2008. These farming and forestry systems can be found in
847 designated sites, such as under Natura 2000, but are also widespread in other (non-
848 designated) areas of countryside, especially on land where agricultural intensification has
849 not occurred to a significant extent (Beaufoy and Cooper 2009). Significant work remains

850 to incorporate High Nature Value farmland into agri-environment policy and practice (The
851 Heritage Council 2010). The new Agri-Environmental Options Scheme (AEOS) aims to
852 identify and protect selected grassland habitats, which would make some progress in the
853 protection of High Nature Value farmland; however, this would probably only represent a
854 small proportion of its area.

855

856 It may be useful to consider a greater differentiation of farmland biodiversity (from Finn
857 2010) that can help guide the prioritisation and development of agri-environment measures
858 for the very different types of biodiversity that may relate to, for example:

- 859 - protection (including restoration) of priority habitats/species on Natura 2000 sites;
- 860 - protection of priority habitats/species that occur outside of Natura 2000 sites;
- 861 - protection of rare and threatened species (e.g. those associated with Red Data Books,
862 Species Action Plans, Flora Protection Orders etc.);
- 863 - protection of other species and habitats of high conservation value;
- 864 - protection of species that are declining, but are not yet rare;
- 865 - protection of other common farmland habitats and species
- 866 - creation of farmland habitat to support named species;
- 867 - creation of common farmland habitats.

868 These different categories represent a broad spectrum of conservation value of species and
869 habitats (which are not necessarily mutually exclusive).

870

871 More demanding environmental objectives in some areas of especially high environmental
872 sensitivity may require measures that exceed the prescriptions of current REPS measures.
873 Recent examples include the Burren (Williams *et al.* 2009), Lough Melvin (Schulte *et al.*
874 2009; Doody *et al.* 2009), commonages (van Rensburg *et al.* 2009) and the Aran Islands
875 and Connemara (Kelly 2008; The Heritage Council 2010). If agri-environment schemes in
876 Ireland are to achieve the objective of halting biodiversity loss, then there is likely to be an
877 increased prioritisation of targeted and evidence-based measures aimed at named species
878 and habitats that are of highest conservation concern. If overall budget allocations do not
879 increase, halting biodiversity loss on farmland will probably require a greater emphasis on
880 'deep and narrow' rather than 'broad and shallow' measures. This process appears to be
881 under way, but will need to be accelerated if the priority objectives of halting biodiversity
882 loss and targeting High Nature Value farmland are to be adequately addressed.

883

Table 1. Description of basic measures in REPS 1 and REPS 4 and associated costs as provided in the Rural Development Plan for Ireland. Costs (€ ha⁻¹ per annum) are based on those applicable to grassland farms only (some differences in costs apply to arable farms) (DAFF 2008). Also indicated for each of the scheme types are the costs of measures associated with biodiversity objectives only.

Measure	Measure name and description	REPS 1	REPS 1	REPS 4	REPS 4
		€	biod. only €	€	biod. only €
M 1	Nutrient management planning	38	0	25	0
M 2	Grassland management plan	14	9.24	10.2	6.73
M 3	Protection and maintenance of watercourses, (water bodies) and wells	18	18	29.3	29.3
M 4	Retention of wildlife habitats	13	13	21.5	21.5
M 5	Maintenance of farm and field boundaries	25	25	30.2	30.2
M 6	Restricted use of pesticides and fertilisers	7.2	7.2	10	10
M 7	The protection of features of historical and archaeological interest	5	0	8	8
M 8	The maintenance and improvement of the visual appearance of farm and farmyard	8	0	0	0
M 10	Training in environmentally friendly farming practices	6	3.96	4.4	2.94
M 11	Maintenance of farm and environmental records	6	3.96	16.5	10.89
	Biodiversity options (REPS 4 only)			17	17
Total		140.2	80.36	172.1	136.53

Table 2. Overview of research relevant to the environmental impacts of REPS.

Topic	Author	Topic/Comment
Nutrient management and gaseous emissions	McEvoy (1999)	Analysis of National Farm Survey data (NFS) showed increased investment in buildings and maintenance due to REPS, as well as reductions in application of chemical fertilisers.
	Casey and Holden (2005, 2006), Lanigan <i>et al.</i> (2008)	Life cycle analyses and discussion of effects of REPS on gaseous emissions.
	Hynes <i>et al.</i> (2007, 2008b)	NFS data showed reductions in nitrogen, phosphorus and methane on REPS farms compared to non-REPS farms within NFS categories.
	Richards <i>et al.</i> (2007) Doody (2009), Schulte (2009)	Lower nitrate losses on REPS treatment, compared to intensive system of beef production. Design of agri-environmental measures to reduce phosphorous loading (L. Melvin)
Archaeology	O'Sullivan (1998, 2001), Sullivan (2005, 2006), Sullivan <i>et al.</i> (1999)	Beneficial impacts of REPS for identification and protection of national sites and monuments
Measure A farmland habitats	Dunford and Feehan (2001), Williams <i>et al.</i> (2009), Walsh (2009)	Management and quality of Burren habitats.
	Visser <i>et al.</i> (2007) Moran <i>et al.</i> (2008) NPWS (2008)	Interviews of turlough farmers, with some responses related to REPS. Out of 42 farmers with turloughs, the 12 in REPS improved their management. National overview of conservation status of priority habitats – most of which had ‘poor’ or ‘bad’ conservation status.
	van Rensburg <i>et al.</i> (2009)	Survey of commonages and effects of REPS participation on selected elements of farm management and farmers’ environmental awareness (but no empirical data on habitat quality).
	O'Rourke and Kramm (2009)	Socio-economics of upland farmland and commonages in the Iveragh Peninsula.
Non-designated farmland habitats	Hickie <i>et al.</i> (1999), Bohnsack and Carrucan (1999), DAF (1999), Jones <i>et al.</i> (2003)	Various references to issues associated with habitat protection and identification.
	Hyde (2003)	Survey of 43 REPS farmers in Co. Galway indicated a need for improved education and awareness of habitats.
	Aughney and Gormally (2002)	Described inadequacies in habitat identification and management.
	Gabbett and Finn (2005)	Identified a desire and need for better wildlife information for REPS planners and demonstration farms.
	Copland (2009), Copland and O'Halloran (2010)	No overall difference in mean density of different types of field boundary, proportion of various farmland habitats, bird diversity or bird density between REPS and non-REPS farms.
	Egan (2006) Hynes <i>et al.</i> (2008a)	Discussion of watercourse margins Investigated match between the spatial distribution of REPS and land use types (but no specific data on habitat quality).

	Speight (2008) Purvis <i>et al.</i> (2009a, p. 17-20)	Critique of expected effects of REPS 4 on habitats and hoverfly diversity. Included REPS status as a variable in multivariate analysis of habitats on 50 farms (thirteen of which were REPS participants)
Field margins	Feehan <i>et al.</i> (2005)	No overall effect of REPS on diversity of plants and beetles in field margins in grassland and tillage areas.
	Fritch <i>et al.</i> (2009, 2011), Purvis <i>et al.</i> (2009a), Sheridan <i>et al.</i> (2008, 2009)	Establishment method and management have large impacts on plant and insect diversity in experimental field margins in grassland; strong effects of intensive grazing.
Hedgerows	Flynn (2002) Copland <i>et al.</i> (2005), Copland (2009)	Related hedgerow characteristics to birds (but low sample sizes). Field boundary management in REPS had little impact on bird populations.
Assessment across multiple environmental objectives	Bartolini <i>et al.</i> (2005), Viaggi <i>et al.</i> (in press) Finn <i>et al.</i> (2007, 2009) Finn <i>et al.</i> (2008b) Kelly (2008) Carlin <i>et al.</i> (2010)	Multi-criteria analysis used to assess the effectiveness of REPS (and Italian scheme) based on data in the mid-term evaluation only. Experts' ratings of measures in REPS 2. REPS 3 farms in case study regions had higher environmental index scores than non-REPS farms (but not representative due to very low sample numbers). Broad discussion of multiple measures and environmental objectives on REPS farms on Aran Islands. Experts' ratings of supplementary measures and options in REPS 4.
Financial effects	McEvoy (1999), Connolly (2005), Connolly <i>et al.</i> (2005, 2006, 2009), Kinsella <i>et al.</i> (2007ab) (and others)	National Farm Survey data includes the effect of REPS on family farm incomes.
Others	Hickie <i>et al.</i> (1999) Emerson and Egdell (1999) Emerson and Gillmor (1999) Gorman <i>et al.</i> (2001) Callanan <i>et al.</i> (2001) An Taisce (2002) Matthews (2002) Costello (2003) McCarthy <i>et al.</i> (2003) Feehan (2003) Finn (2003), Harte and O'Connell (2003) Finn <i>et al.</i> (2005) Rath <i>et al.</i> (2005) GFA Consulting Group (2006)	Analysis of REPS policy. Comparison of agri-environment schemes in Ireland and Scotland. Detailed description of REPS participation. REPS and farm livelihoods. As part of a wider evaluation study, included survey responses about REPS. Detailed discussion of monitoring and evaluation. General critique of REPS with economic emphasis. Survey respondents (n=97) at REPS courses (Co. Clare) indicated broad satisfaction with courses, and increased environmental awareness and ability to implement their REPS plan . Analysis of afforestation, and effects of REPS on afforestation. Discussion of monitoring and evaluation. General discussion of agri-environment policy and issues, with reference to REPS. Identification of environmental indicators for REPS. Discussion of the achievements and future challenges for REPS. Qualitative assessment of expected impacts of REPS (no reference to published evidence).

O'Connell and Harte (2006), Matthews (2008)	General critique of REPS 3, with economic emphasis.
Campbell (2007), Campbell <i>et al.</i> (2006, 2008, 2009), Scarpa <i>et al.</i> (2007)	Survey of public response to landscape effects of REPS, with results on preferences, willingness-to-pay and methodological developments.
Hynes and Hanley (2009)	Survey of REPS and non-REPS farmers on economics of corncrake conservation.
Ducos <i>et al.</i> (2009), Hynes and Garvey (2009)	Factors affecting farmers' participation in REPS.
Beckmann <i>et al.</i> (2009), Lenihan and Brasier (2009)	Description of institutional relationships among different stakeholders in REPS.
Primdahl <i>et al.</i> (2010)	Use of impact models in selected schemes across Europe (including REPS).
Finn (2010)	Design and estimate of costs of environmental monitoring of REPS.
Whelan and Fry (2010)	Discussion of the requirement for Strategic Environmental Assessment of REPS, with emphasis on landscape protection.
Whelan <i>et al.</i> (in press)	Discussion of the terminology of landscape categorisation used in REPS.

References

- AFCOn 2003 *CAP Rural Development Plan 2000-2006. Mid-Term Evaluation*. AFCOn Management Consultants in association with University College Cork.
- AFCOn 2006 *Rural Development Programme 2007-13: Ex Ante Evaluation*. AFCOn Management Consultants with Jim Dorgan Associates.
- An Taisce 2002 *Monitoring and Evaluation of the Rural Environment Protection Scheme*. Dublin. An Taisce.
- Asteraki, E.J., Hanks, C.B. and Clements, R.O. 1995 The influence of different types of grassland field margin on carabid beetle (Coleoptera, Carabidae) communities. *Agriculture Ecosystems & Environment* **54**, 195-202.
- Aughney, T. and Gormally, M. 2002 The nature conservation value of lowland farm habitats on REPS and non-REPS farms in County Galway and the use of traditional farm methods for habitat management under the Rural Environment Protection Scheme (REPS). *Tearmann: Irish Journal of Agri-Environmental Research* **2**, 1-14.
- Bakker, J. P. and Berendse, F. 1999 Constraints in the restoration of ecological diversity in grassland and heathland communities. *Trends in Ecology and Evolution* **14**, 63-68.
- Bartolini, F., Finn, J.A., Kurz, I., Samoggia, A. and Viaggi, D. 2005 Using information from mid-term evaluations of RDP for the multicriteria analysis of agri-environmental schemes. In *2005 International Congress*. Copenhagen. European Association of Agricultural Economists. <http://ageconsearch.umn.edu/bitstream/24738/1/cp05ba03.pdf>
- Beaufoy, G. 2008 *HNV Farming - Explaining the concept and interpreting EU and national policy commitments*. Stratford-upon-Avon. European Forum on Nature Conservation and Pastoralism. www.efncp.org/download/EFNCP-HNV-farming-concept.pdf
- Beaufoy, G. and Cooper, T. 2009 *The Application of the High Nature Value Impact Indicator 2007-2013*. European Evaluation Network for Rural Development. http://ec.europa.eu/agriculture/rurdev/eval/hnv/guidance_en.pdf
- Beckmann, V., Eggers, J. and Mettepenningen, E. 2009 Deciding how to decide on agri-environmental schemes: the political economy of subsidiarity, decentralisation and participation in the European Union. *Journal of Environmental Planning and Management* **52**, 689-716.

- Birdwatch Ireland 2010 Birds of Conservation Concern In Ireland – BoCCI. Online article. Wicklow. Birdwatch Ireland. <http://www.birdwatchireland.ie/Ourwork/SurveysProjects/BirdsofConservationConcern/tabid/178/Default.aspx>
- Bohnsack, U. and Carrucan, P. 1999 *An Assessment of Farming Prescriptions under the Rural Environment Protection Scheme in the Uplands of the Burren Karstic Region, Co. Clare*. Kilkenny. The Heritage Council.
- Bokenstrand, A., Lagerlöf, J. and Torstensson, P.R. 2004 Establishment of vegetation in broadened field boundaries in agricultural landscapes. *Agriculture, Ecosystems & Environment* **101**, 21-29.
- Bro, E., Mayot, P., Corda, E. and Reitz, F. 2004 Impact of habitat management on grey partridge populations: assessing wildlife cover using a multisite BACI experiment. *Journal of Applied Ecology* **41**, 846-857.
- Callanan, S., Cuddy, M. and Morand, F. 2001 *Methodology for the Evaluation of Rural Development Policy Measures*. Galway. National University of Ireland.
- Campbell, D. 2007 Willingness to pay for rural landscape improvements: Combining mixed logit and random-effects models. *Journal of Agricultural Economics* **58**, 467-483.
- Campbell, D., Hutchinson, W.G. and Scarpa, R. 2008 Incorporating discontinuous preferences into the analysis of discrete choice experiments. *Environmental and Resource Economics* **41**, 401-417.
- Campbell, D., Hutchinson, W.G. and Scarpa, R. 2009 Using choice experiments to explore the spatial distribution of willingness to pay for rural landscape improvements. *Environment and Planning A* **41**, 97 - 111.
- Campbell, D., Hutchinson, W.G., Scarpa, R., O'Leary, T., McCormack, A. and Riordan, B. 2006 Quantifying the landscape benefits arising from the Rural Environment Protection Scheme: results from a public survey. *Teirmann: Irish Journal of Agri-Environmental Research* **5**, 1-12.
- Carlin, C., Gormally, M., Ó hUallacháin, D. and Finn, J.A. 2010 *Experts' assessments of biodiversity options and supplementary measures in REPS 4*. Galway. National University of Ireland.
- Casey, J.W. and Holden, N.M. 2005 The relationship between greenhouse gas emissions and the intensity of milk production in Ireland. *Journal of Environmental Quality* **34**, 429-436.

- Casey, J.W. and Holden, N.M. 2006 Greenhouse gas emissions from conventional, agri-environmental scheme, and organic Irish suckler-beef units. *Journal of Environmental Quality* **35**, 231-239.
- CEC 2008 *A mid-term assessment of implementing the EC Biodiversity Action Plan*. Brussels. Commission of the European Communities. <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2008:0864:FIN:EN:PDF>
- Clarke, J.D. 1998 *A study on the uptake of the Rural Environmental Protection Scheme in Co. Louth in the first four years of the operation of the scheme*. Dublin. University College Dublin.
- COM 2009a *Composite Report on the Conservation Status of Habitat Types and Species as required under Article 17 of the Habitats Directive*. Brussels. Commission of the European Communities.
- COM 2009b *Towards a better targeting of the aid to farmers in areas with natural handicaps*. Vol. 161. Brussels. Commission of the European Communities.
- Connolly, L. 2005 Financial impact of Rural Environment Protection Scheme. In *REPS 3 – Assisting Change in Farming*, 18-24. Carlow. Teagasc.
- Connolly, L., Kinsella, A., Cushion, M. and Moran, B. 2006 Financial impact of REPS. In *Agricultural Research Forum 2006*, 36. Carlow. Teagasc.
- Connolly, L., Kinsella, A., Quinlan, C. and Moran, B. 2005 *Analysis of REPS/Non-REPS Farms - National Farm Survey 2003*. Carlow. Teagasc.
- Connolly, L., Kinsella, A., Quinlan, G. and Moran, B. 2009 *National Farm Survey 2008*. Carlow. Teagasc.
- Cooper, T., Hart, K. and Baldock, D. 2009 *The Provision of Public Goods Through Agriculture in the European Union*. London. Institute for European and Environmental Policy.
- Copland, A. 2009 Bird Populations of Lowland Irish Farmland (with special reference to agri-environment measures). PhD thesis. Cork. National University of Ireland.
- Copland, A., O'Halloran, J. and Murphy, J. 2005 Maximising the biodiversity impacts of REPS. In *REPS 3 – Assisting Change in Farming*, 33-44. Carlow. Teagasc.
- Copland, A.S. and O'Halloran, J. 2010 Agri-environment impacts and opportunities for summer bird communities on lowland Irish farmland. *Aspects of Applied Biology* **100**, 77-87.
- Costello, D. 2003 A study of REPS 2000 training courses in Co. Clare. M.Agr.Sc thesis. Dublin. University College Dublin.

- Council of the European Union 2010 Biodiversity: Post 2010. EU and global vision and targets and international ABS regime. Council Conclusions., Vol. **7536/10**, Brussels.
- Court of Auditors 2000 Special Report No. 14/2000 on 'Greening the Cap' together with the Commission's replies. *Official Journal of the European Communities C 353*, 1-56.
- Court of Auditors 2003 Special Report No 4/2003 concerning rural development: support for less-favoured areas, together with the Commission's replies. *Official Journal of the European Union 46*, 1-24.
- Court of Auditors 2005 Special Report No 3/2005 concerning rural development: the verification of agri-environment expenditure, together with the Commission's replies. *Official Journal of the European Communities C 353 C 279*, 1-29.
- Court of Auditors 2006 Special Report No 7/2006 concerning rural development investments: do they effectively address the problems of rural areas? together with the Commission's replies. *Official Journal of the European Communities C282*, 1-31.
- Curtin, J. and Whelan, J. 1998 A study of farms participating in the REPS Scheme in Country Roscommon and benefits to the rural environment of this scheme in its present form. In *Protecting Ireland's National Heritage*, 18-19. Wexford. Teagasc.
- DAF 1999 *Evaluation of the Rural Environment Protection Scheme*. Dublin. Department of Agriculture and Food.
- DAFF 2007 *Ireland CAP Rural Development Programme 2007-2013*. Dublin. Department of Agriculture, Fisheries and Food.
- DAFF 2008 *REPS Facts and Figures 2007*. Dublin. Department of Agriculture, Fisheries and Food.
www.agriculture.gov.ie/farmerschemespayments/ruralenvironmentprotectionschemereps/
- DAFF 2009 *REPS Facts and Figures 2008*. Dublin. Department of Agriculture, Fisheries and Food.
- DAFF 2010 *Burren Farming for Conservation Programme*. Dublin. Department of Agriculture, Fisheries and Food.
www.agriculture.gov.ie/farmerschemespayments/otherfarmerssschemes/burrenfarmingforconservationprogramme/
- DAHGI 2002 *National Biodiversity Plan*. Dublin. Department of Arts, Heritage, Gaeltacht and the Islands.

- DG Agriculture 2004 *Impact assessment of rural development programmes in view of post-2006 rural development policy*. Brussels. European Commission.
- Doody, D.G., Schulte, R.P.O., Byrne, P. and Carton, O.T. 2009 Stakeholder participation in the development of agri-environmental measures. *Tearmann: Irish Journal of Agri-Environmental Research* **7**, 229-240.
- Douglas, D.J.T., Vickery, J.A. and Benton, T.G. 2009 Improving the value of field margins as foraging habitat for farmland birds. *Journal of Applied Ecology* **46**, 353-362.
- Drennan, M.J. and McGee, M. 2009 Performance of spring-calving beef suckler cows and their progeny to slaughter on intensive and extensive grassland management systems. *Livestock Science* **120**, 1-12.
- Ducos, G., Dupraz, P. and Bonnieux, F. 2009 Agri-environment contract adoption under fixed and variable compliance costs. *Journal of Environmental Planning and Management* **52**, 669-687.
- Dunford, B. and Feehan, J. 2001 Agricultural practices and natural heritage: a case study of the Burren Uplands, Co. Clare. *Tearmann: Irish Journal of Agri-Environmental Research* **1**, 19-34.
- Egan, E. 2006 Purpose, management and characteristics of the fenced off watercourse margin: a REPS planners review. *Tearmann: Irish Journal of Agri-Environmental Research* **5**, 61-78.
- Emerson, H. and Egdell, J. 1999 The contrasting implementation of the EU agri-environment regulation in Ireland and Scotland. *European Environment* **9**, 154-166.
- Emerson, H.J. and Gillmor, D. A. 1999 The Rural Environment Protection Scheme of the Republic of Ireland. *Land Use Policy* **16**, 235-245.
- European Commission 1998 *State of application of regulation (EEC) No 2078/92: Evaluation of Agri-Environment Programmes*. DGVI Commission Working Document, VI/7655/98. Brussels. European Commission.
- European Commission 2006 *Rural Development Policy 2007-2013: Handbook on common monitoring and evaluation framework*. Brussels. Directorate General for Agriculture and Rural Development.
http://ec.europa.eu/agriculture/rurdev/eval/guidance/document_en.pdf
- European Court of Auditors 2008 *Special Report No 8 Is cross compliance an effective policy?* Luxembourg. European Court of Auditors.

- Fahey, L. 2010 *REPS & AEOS*. Presentation at Teagasc Agri-environment Conference, 7th September, 2010. Carlow. Teagasc. www.teagasc.ie/publications/2010/20100907/index.asp
- Feehan, J. 2003 Investing in monitoring and evaluation: an overview of practical approaches to biodiversity monitoring of agri-environment schemes. *Tearmann: Irish Journal of Agri-Environmental Research* **3**, 17-26.
- Feehan, J., Gillmor, D.A. and Culleton, N.E. 2005 Effects of an agri-environment scheme on farmland biodiversity in Ireland. *Agriculture, Ecosystems & Environment* **107**, 275-286.
- Fenton, O., Coxon, C.E., Haria, A.H., Horan, B., Humphreys, J., Johnson, P., Murphy, P., Necpalova, M., Premrov, A. and Richards, K.G. 2010 Variations in travel time and remediation potential for N loading to groundwaters in four case studies in Ireland: Implications for policy makers and regulators. *Tearmann: Irish Journal of Agri-Environmental Research* **7**, 129-142.
- Finn, J.A. 2003 The agri-environmental measure of the Rural Development Regulation (1257/99): an overview of policy issues. *Tearmann: Irish Journal of Agri-Environmental Research* **3**, 1-12.
- Finn, J.A. 2010 *Monitoring the environmental impacts of the Rural Environment Protection Scheme: a scoping study*. Carlow. Teagasc.
- Finn, J.A., Kavanagh, B. and Flynn, M. 2005 *Identification of environmental variables for use in monitoring for the evaluation of the Rural Environment Protection Scheme (REPS)*. (2001-EEA/DS-10-M2). Final Report. Wexford. Environmental Protection Agency.
- Finn, J.A., Bourke, D., Kurz, I. and Dunne, L. 2007 *Estimating the environmental performance of agri-environmental schemes via use of expert consultations*. ITAES Final Report to European Commission. France. INRA. <http://merlin.lusignan.inra.fr/ITAES/website/Publicdeliverables>
- Finn, J.A., Kurz, I. and Bourke, D. 2008a Multiple factors control the environmental effectiveness of agri-environmental schemes: implications for design and evaluation. *Tearmann: Irish Journal of Agri-Environmental Research* **6**, 45-56.
- Finn, J.A., Louwagie, G., Northey, G., Purvis, G. and AE-Footprint project 2008b Use of the agri-environmental footprint index (AFI) to evaluate environmental effectiveness of the REPS. *Using Evaluation to Enhance the Rural Development Value of Agri-environmental Measures*. Pärnu. Agricultural Research Centre. <http://pmk.agri.ee/pkt/CD/>

- Finn, J.A., Bartolini, F., Kurz, I., Bourke, D. and Viaggi, D. 2009 *Ex post* environmental evaluation of agri-environment schemes using experts' judgements and multicriteria analysis. *Journal of Environmental Management and Planning* **52**, 717-737.
- Flynn, E.M. 2002 An investigation of the Relationship between Avian Biodiversity and Hedgerow Management as predicted under the Rural Environmental Protection Scheme (REPS). PhD thesis. Dublin. Royal College of Surgeons.
- Fritch, R., Sheridan, H., Ó hUallacháin, D., Kirwan, L. and Finn, J.A. 2009 Enhancing plant diversity within field margins in intensive grassland. In *Agricultural Research Forum 2009*, 129. Carlow. Teagasc.
- Fritch, R.A., Sheridan, H., Finn, J.A., Kirwan, L. and Ó hUallacháin, D. 2011 Methods of enhancing botanical diversity within field margins of intensively managed grassland: a 7-year field experiment. *Journal of Applied Ecology* in press. (doi: 10.1111/j.1365-2664.2010.01951.x).
- Gabbett, M. and Finn, J.A. 2005 *The Farmland Wildlife Survey*. Carlow. Teagasc.
- GFA Consulting Group 2006 Analysis of the requirements for soil and biodiversity protection as well as for greenhouse gas mitigation within the Rural Development Programmes. Hamburg. GFA Consulting Group
- Gorman, M., Mannion, J., Kinsella, J. and Bogue, P. 2001 Connecting environmental management and farm household livelihoods: The Rural Environment Protection Scheme in Ireland. *Journal of Environmental Policy and Planning* **3**, 137-147.
- Harte, L. and O'Connell, J. 2003 How well do agri-environmental payments conform with multifunctionality? *EuroChoices* **2**, 36-41.
- Hickie, D., Smyth, E., Bohnsac, U., Scott, S. and Baldock, D. 1999 *Impact of Agricultural Schemes and Payments on Aspects of Ireland's Heritage*. Kilkenny. The Heritage Council.
- Hyde, T. 2003 A study of farmer's attitudes and wildlife habitats on a sample of farms, participating in Reps II in County Galway. M.Agr.Sc thesis. Dublin. University College Dublin.
- Hynes, S. and Garvey, E. 2009 Modelling farmers' participation in an agri-environmental scheme using panel data: an application to the Rural Environment Protection Scheme in Ireland. *Journal of Agricultural Economics* **60**, 546-562.
- Hynes, S. and Hanley, N. 2009 The "*Crex crex*" lament: estimating landowners willingness to pay for corncrake conservation on Irish farmland. *Biological Conservation* **142**, 180-188.

- Hynes, S., Kinsella, A. and Farrelly, N. 2007 A decade on - the effect of the Rural Environment Protection Scheme on national farming practices in Ireland. In *Agricultural Research Forum 2007*, 20, Carlow. Teagasc.
- Hynes, S., Farrelly, N., Murphy, E. and O'Donoghue, C. 2008a Modelling habitat conservation and participation in agri-environmental schemes: a spatial microsimulation approach. *Ecological Economics* **66**, 258-269.
- Hynes, S., O'Donoghue, C., Murphy, E. and Kinsella, A. 2008b The impact of REPS participation on farm chemical input usage and the production of negative externalities. *Tearmann: Irish Journal of Agri-Environmental Research* **6**, 15-28.
- Jones, L., Gwyn, D., Bignal, E., Lysaght, L., Baldock, D. and Phelan, J. 2003 *A Review of the CAP Rural Development Plan 2000-2006: Implications for Natural Heritage*. Kilkenny. The Heritage Council.
- Kapos, V., Balmford, A., Aveling, R., Bubb, P., Carey, P., Entwistle, A., Hopkins, J., Mulliken, T., Safford, R., Stattersfield, A., Walpole, M. and Manica, A. 2009 Outcomes, not implementation, predict conservation success. *Oryx* **43**, 336-342.
- Kelly, I. 2008 *A Study of the Rural Environment Protection Scheme on the Aran Islands*. MSc thesis. Dublin, University College Dublin.
- Kinsella, A., Connolly, L. and Quinlan, C. 2007a *Analysis of REPS farms. National Farm Survey - 2005*. Carlow. Teagasc.
- Kinsella, A., Moran, B., and Quinlan, G. 2007b *Financial and technical analysis of REPS/non-REPS farms. National Farm Survey - 2007*. Athenry. Teagasc.
- Kleijn, D. and Sutherland, W.J. 2003 How effective are European agri-environment schemes in conserving and promoting biodiversity? *Journal of Applied Ecology* **40**, 947-969.
- Kronvang, B., Jeppesen, E., Conley, D.J., Søndergaard, M., Larsen, S.E., Ovesen, N.B. and Carstensen, J. 2005 Nutrient pressures and ecological responses to nutrient loading reductions in Danish streams, lakes and coastal waters. *Journal of Hydrology* **304**, 274-288.
- Lanigan, G., O'Mara, F., Murphy, J., Finnan, J. O'Kiely, P. and Richards, K. 2008 Gaseous emissions in agriculture: challenges & opportunities. In *Helping to build sustainable Rural Communities*, 8-20. Carlow. Teagasc.
- Lee, D.C. and Bradshaw, G.A. 2004 *Making monitoring work for managers: thoughts on a conceptual framework for improved monitoring within broad-scale ecosystem management efforts*. Online publication.

- Lenihan, M.H. and Brasier, K.J. 2009 Scaling down the European model of agriculture: the case of the Rural Environmental Protection Scheme in Ireland. *Agriculture and Human Values* **26**, 365-378.
- MacDonald, D., Crabtree, J.R., Wiesinger, G., Dax, T., Stamou, N., Fleury, P., Lazpita, J.G. and Gibon, A. 2000 Agricultural abandonment in mountain areas of Europe: Environmental consequences and policy response. *Journal of Environmental Management* **59**, 47-69.
- Marshall, E.J.P. and Arnold, G.M. 1995 Factors affecting field weed and field margin flora on a farm in Essex, UK. *Landscape and Urban Planning* **31**, 205-216.
- Marshall, E.J.P. and Moonen, A.C. 2002 Field margins in northern Europe: their functions and interactions with agriculture. *Agriculture, Ecosystems & Environment* **89**, 5-21.
- Matthews, A. 2002 Has agricultural policy responded to the Rio challenge? In F. Convery and J. Feehan (eds.), *Achievement and Challenge. Rio+10 and Ireland*, 73-82. Dublin. The Environmental Institute.
- Matthews, A. 2008 European Rural Development policy – implications for agri-environment schemes. In *Helping to build sustainable Rural Communities*, 21-31. Carlow. Teagasc.
- McEvoy, O. 1999 Impact of REPS – analysis from the National Farm Survey. Dublin. Teagasc.
- McEvoy, P.M., Flexen, M. and McAdam J. H. 2006 The Environmentally Sensitive Area (ESA) scheme in Northern Ireland: ten years of agri-environment monitoring. *Biology and Environment* **106**, 413-423.
- McCarthy, S., Matthews, A. and Riordan, B. 2003 Economic determinants of private afforestation in the Republic of Ireland. *Land Use Policy* **20**, 51-59.
- Meek, B., Loxton, D., Sparks, T., Pywell, R., Pickett, H. and Nowakowski, M. 2002 The effect of arable field margin composition on invertebrate biodiversity. *Biological Conservation* **106**, 259-271.
- Moran, J. 2009 *Forage quality of semi natural calcareous grasslands and heaths of the Burren*. Athenry. Teagasc. www.burrenlife.com/Userfiles/forage-quality-of-semi-natural-calcareous-grasslands-and-heaths.pdf
- Moran, J., Regan, E.C., Visser, M., Gormally, M. and Sheehy Skeffington, M. 2008 Past and present land management of 12 turloughs in the west of Ireland. *Tearmann: Irish Journal of Agri-Environmental Research* **6**, 83-102.

- National Botanic Gardens 2005 *A National Plant Conservation Strategy for Ireland*. Dublin. National Botanic Gardens.
- NPWS 2008 *The Status of EU Protected Habitats and Species in Ireland*. Dublin. National Parks and Wildlife Service.
- O'Connell, J. and Harte, L. 2006 REPS 3 - a small step in an economic direction? *Tearmann: Irish Journal of Agri-Environmental Research* **5**, 13-22.
- O'Sullivan, M. 1998 Evaluation of Measure 7 in REPS in relation to archaeological and historical sites. In *Protecting Ireland's National Heritage*. Wexford. Teagasc.
- O'Sullivan, M. 2001 The past may not always be with us: archaeological remains in farmland. *Tearmann: Irish Journal of Agri-Environmental Research* **1**, 55-63.
- O'Sullivan, M. and Kennedy, L. 1998 The survival of archaeological monuments: trends and attitudes. *Irish Geography* **31**, 88-99.
- O'Rourke, E. and Kramm, N. 2009 Changes in the management of the Irish uplands: a case study from the Iveragh Peninsula. *European Countryside* **1**, 53-69.
- Oréade-Brèche 2005 *Evaluation of agri-environmental measures. Annex 14: Etude nationale Irlande*. Auzeville. Oréade-Brèche.
http://ec.europa.eu/agriculture/eval/reports/measures/index_fr.htm
- Parr, S., O'Donovan, G. and Finn, J.A. 2006 Mapping the broad habitats of the Burren using satellite imagery. End of Project Report. Teagasc.
<http://www.teagasc.ie/research/reports/environment/5190c/eopr5190c.asp>
- Parr, S., O'Donovan, G., Ward, S. and Finn, J.A. 2009 Vegetation analysis of upland Burren grasslands of conservation interest. *Biology and Environment* **109B**, 11-33.
- Potter, C. and Burney, J. 2002 Agricultural multifunctionality in the WTO - legitimate non-trade concern or disguised protectionism? *Journal of Rural Studies* **18**, 35-47.
- Primdahl, J., Vesterager, J.P., Finn, J.A., Vlahos, G., Kristensen, L. and Vejre, H. 2010 Current use of impact models for agri-environment schemes and potential for improvements of policy design and assessment. *Journal of Environmental Management* **91**, 1245-1254.
- Purvis, G., Anderson, A., Baars, J.-R., Bolger, T., Breen, J., Connolly, J., Curry, J., Doherty, P., Doyle, M., Finn, J., Geijzendorffer, I., Helden, A., Kelly-Quinn, M., Kennedy, T., Kirwan, L., McDonald, J., McMahan, B., Mikcshe, D., Santorum, V., Schmidt, O., Sheehan, C. and Sheridan, H. 2009a *AG-BIOTA- monitoring, functional significance and management for the maintenance and economic utilisation of biodiversity in the intensively farmed landscape*. Wexford. Environmental Protection Agency.

- Purvis, G., Louwagie, G., Northey, G., Mortimer, S., Park, J., Mauchline, A., Finn, J., Primdahl, J., Vejre, H., Vesterager, J.P., Knickel, K., Kasperczyk, N., Balazs, K., Vlahos, G., Christopoulos, S. and Peltola, J. 2009b Conceptual development of a harmonised method for tracking change and evaluating policy in the agri-environment: The Agri-environmental Footprint Index. *Environmental Science & Policy* **12**, 321-337.
- Quillérou, E. and Fraser, R. 2010 Adverse selection in the Environmental Stewardship Scheme: does the Higher Level Stewardship Scheme design reduce adverse selection? *Journal of Agricultural Economics* **61**, 369-380.
- Rath, F., Muldowney, J. and Carty, J. 2005 The future focus and priority of biodiversity in the Rural Environmental Protection Scheme (REPS). *Tearmann: Irish Journal of Agri-Environmental Research* **4**, 23-28.
- Richards, K., Drennan, M., Lenehan, J.J., Connolly, J., Brophy, C. and Carton, O.T. 2007 Nitrate leaching from Irish beef farming, a look at the impact of REPS. In *Agricultural Research Forum 2007*, 3. Carlow. Teagasc. www.agresearchforum.com/publicationsarf/2007/Page%20003.pdf
- Scarpa, R., Campbell, D. and Hutchinson, W.G. 2007 Benefit estimates for landscape improvements: sequential Bayesian design and respondents' rationality in a choice experiment. *Land Economics* **83**, 617-634.
- Schulte, R.P.O., Doody, D.G., Byrne, P., Cockerill, C. and Carton, O.T. 2009 Lough Melvin: Developing cost-effective measures to prevent phosphorus enrichment of a unique aquatic habitat. *Tearmann: Irish Journal of Agri-Environmental Research* **7**, 211-228.
- Sheridan, H., Finn, J.A., Culleton, N.E. and O'Donovan, G. 2008 Plant and invertebrate diversity in grassland field margins. *Agriculture, Ecosystems & Environment* **123**, 225-232.
- Sheridan, H., Finn, J.A. and O'Donovan, G. 2009 Botanical rejuvenation of field margins and benefits for invertebrate fauna on a drystock farm in County Longford. *Biology and Environment-Proceedings of the Royal Irish Academy* **109B**, 95-106.
- Speight, M.C.D. 2008 *Database of Irish Syrphidae (Diptera)*. *Irish Wildlife Manual No. 36*. Dublin. National Parks and Wildlife Service.
- Stobbelaar, D.J., Groot, J.C.J., Bishop, C., Hall, J. and Pretty, J. 2009 Internalization of agri-environmental policies and the role of institutions. *Journal of Environmental Management* **90**, S175-S184.

- Sullivan, C. 2010 Identification of High Nature Value (HNV) farmland on lowland farms in East County Galway, Western Ireland. PhD thesis. Galway. National University of Ireland.
- Sullivan, C.A., Bourke, D., Gormally, M.J., Sheehy Skeffington, M., Finn, J.A., Green, S. and Kelly, S. Use of generalised additive models to estimate area of semi-natural habitats on lowland farms in western Ireland. *Biological Conservation* in press. (doi:10.1016/j.biocon.2010.12.028).
- Sullivan, E. 2005 The Irish farm in the context of the Rural Environment Protection Scheme - an Archaeological Perspective. PhD thesis. Dublin. National University of Ireland.
- Sullivan, E. 2006 The archaeology of REPS - seeing is believing. In *New challenges*, 50-52. Carlow. Teagasc.
- Sullivan, E., Flynn, M., Feehan, J. and Dunford, B. 1999 Approaches to evaluating some REPS measures. In *Impact and Future Direction of REPS*, 18-23. Wexford. Teagasc.
- The Heritage Council. 2010 *Case studies on High Nature Value Farming in Ireland. North Connemara and the Aran Islands*. Kilkenny. The Heritage Council.
- Van Rensburg, T.M., Murphy, E. and Rocks, P. 2009 Commonage land and farmer uptake of the rural environment protection scheme in Ireland. *Land Use Policy* **26**, 345-355.
- Viaggi, D., Finn, J.A., Kurz, I. and Bartolini, F. Multicriteria analysis for environmental assessment of agri-environment schemes: how to use partial information from Mid-Term Evaluations? *Agricultural Economics Review*, in press.
- Visser, M., Moran, J., Regan, E., Gormally, M. and Sheehy Skeffington, M. 2007 The Irish agri-environment: how turlough users and non-users view converging EU agendas of Natura 2000 and CAP. *Land Use Policy* **24**, 362-373.
- Walsh, K. 2009 *The voice on the ground: A survey of the needs of Burren farm families*. Dunboyne. Burrenbeo Trust Limited.
- Whelan, J., and Fry, J. 2010 Transition to the Green Economy: Using SEA to evaluate agri-environmental objectives and performance. In *The Role of Impact Assessment in Transitioning to the Green Economy*. 30th Annual Meeting of the International Association for Impact Assessment. (Online.) Geneva. Switzerland.
- Whelan, J., Fry, J., and Green, S. A contribution to standardising terminology for landscape categorisation - an Irish agri-environment perspective *Études Irlandaises* in press.

- Williams, B., Parr, S., Moran, J., Dunford, B. and Ó Conchúir, R. 2009 The Burren-farming for the future of the fertile rock. *British Wildlife* **21**, 1-9.
- Woodcock, B.A., Westbury, D.B., Potts, S.G., Harris, S.J. and Brown, V.K. 2005 Establishing field margins to promote beetle conservation in arable farms. *Agriculture, Ecosystems & Environment* **107**, 255-266.
- Wu, J. and Skelton-Groth, K. 2002 Targeting conservation efforts in the presence of threshold effects and ecosystem linkages. *Ecological Economics* **42**, 313-331.