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February 8, 2013

Dr. Bernard Bulkin
Office of Renewable Energy Deployment
UK Department of Climate Change

Re: Observations and Information Related to DECC Supplementary Statement of November 22, 2012 Regarding UK Bioenergy Strategy

Dear Dr. Bulkin,

I was pleased to see that the statement released by DECC on November 22, 2012 clarified DECC's analysis that the original use for bioenergy of the stemwood (whole trees) harvested from UK forests directly for electricity increases greenhouse gas emissions (GHGs). In places, however, the statement and your accompanying blog could be interpreted to suggest that in some contexts the deliberate harvest of stemwood for energy or the diversion of stemwood from other uses could reduce greenhouse gasses. Your blog also appeared to raise questions about whether whole trees harvested abroad might have a different result. I offer some additional information for your consideration, which leads to five observations:

One, according to the scenarios the DECC statement presents, there appears to be no technical dispute that woody biomass can only produce greenhouse gas savings if it would otherwise result from a form of wood waste. That may include residues (tops and branches), small roundwood and off-cuttings from sawmills, *but only if that small roundwood or those off-cuttings would not otherwise be used*.

Two, unless DECC adopts rules restricting biomass supply to these waste wood sources and other low carbon biomass, the UK's bioenergy cannot derive even substantially from these kinds of wastes because their maximum supply is far less than the UK bioenergy plans. Indeed, if *100% of UK's annual harvest* of wood were devoted to electricity with no wood left for wood products, that would generate only 3% of UK electricity or 1.3% of UK primary energy.

Three, although it is true that the UK Bioenergy Strategy did not examine forests outside the UK, peer-reviewed analyses of virtually every other kind of forest and potential harvest strategy have come to the same "take home" conclusion. In particular, according to these analyses, neither "thinning" harvests nor harvests of fast-growing U.S. pine plantations reduce GHGs when used for electricity.

Four, because the potential energy supply even from the use of 100% of harvest residues in both Canada and the U.S. is also small, they are unlikely to constitute the supplies of low biomass for the UK unless rules carefully restrict biomass based on proper biomass accounting.

Five, DECC has yet to propose criteria that would restrict biomass to sources that are truly low carbon. A potential requirement for "sustainable" forest management, however welcome, would not address carbon accounting. Indeed, the Bioenergy Strategy found that the use of stemwood from UK forests does not reduce GHGs (unless otherwise wasted) even while expressing the view that UK forests are sustainably managed.

These observations all indicate the importance of the government adopting proper restrictions of woody biomass used for energy based on proper biomass accounting.

I. DECC's analysis shows that only waste wood can produce greenhouse gas reductions.

In a short report I have previously provided to DECC,[1] and in a report by the NGO community, the basic message was that DECC's analysis for the bioenergy strategy showed that the direct use of whole trees for bioenergy, as opposed to timber harvest residues, increased greenhouse gas emissions. In its Supplementary Statement from last November 22, DECC stated states that "the use of wood from managed UK forests for bioenergy (in place of fossil fuels) usually has greater GHG benefits than leaving the trees unharvested in the forest, provided that it is produced as a co-product of wood utilized for materials (in place of alternative materials, e.g., concrete)." A closer analysis of the results presented in this statement shows that in all cases the use of wood only reduces greenhouse gas emissions if that harvested wood would otherwise not be used.

In all scenarios presented in the supplemental statement, the primary use of the wood is sawn timber in the case of large trees. In all cases, bioenergy uses bark and "branchwood." Those are simply other terms for "residues" as they are precisely what is typically left in the forest when harvesting stemwood.

[1] Searchinger T, 2012. Sound principles and an important inconsistency in the 2012 UK bioenergy strategy (manuscript)

The scenarios differ only then by whether the "off-cut" of saw logs or small roundwood is used for fuel or some other product. And here is the key point: The use of offcuts and small roundwood for fuel *never* generates a greenhouse gas reduction by comparison with any alternative use of that wood for particle board, MSD, pellets or fencing. At best, in some scenarios, the diversion of small roundwood or offcuts to fuel would not result in an increase or decrease in greenhouse gas emissions. That leaves two options even in theory. If these off-cuts would be used for alternative purposes if not used for bioenergy, using them for bioenergy generates <u>no</u> greenhouse gas reduction. If they would not be used, there would be a reduction. Saying these off-cuts would not be used is another way of saying they would be waste.

In combination, if any wood either would remain in the forest or alternatively would be used for any kind of wood products, its diversion to bioenergy does not reduce greenhouse gas emissions.[2]

In reality, the chance that off-cuts would otherwise be thrown away is small. Wood off-cuttings for particle board and other manufactured products are in high demand. One report found that the UK's problem is not an abundance of such product but a shortage.[3] In general, worldwide, offcut material that cannot be used for such products is burned as a source of energy by or near the mills. UK Forestry Commission data show extensive use of off-cut material already.[4]

2. **Without new rules restricting the types of wood that may be used, DECC cannot assure greenhouse gas reductions because the potential supply of wood wastes is too small.**

Today, DECC has no rules limiting the supply of wood to these various forms of waste. Without such rules, these wastes cannot meet the UK's bioenergy targets for the simple reason that they are extremely small. Here are a few measures.

- Using DECC figures, the use of even 100% of UK timber harvest for bioenergy would supply 2.9% of UK electricity.

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[2] The UK Bioenergy Strategy strategy explicitly recognizes that policy "should only support bioenergy where the reductions in emissions through the use of bioenergy exceed any new emissions created *as a consequence of the policy*." P. 18. That means any use of wood product must be compared with its alternative, which in the case of off-cuttings, means any alternative use.
[3] Europe Economics, 2010. The Wood Panel Industry in the UK: A Report of the Wood Panel Industries Federation, London
[4] www.forestry.gov.uk/website/forstats2012.nsf/0/824A4E0E2DDEDC858025731B00541EFF?open&RestrictToCategory=1

- If the UK were to restrict itself to residues, that figure would be a maximum of 0.9% of UK electricity supply. This calculation assumes that residues are 30% of harvest, that all residues are presently unused, and that no residues will be left n the forest.

- Assuming very generously that 15% of all presently harvested wood becomes available as unused offcuts, it would supply 0.4% of UK electricity.

- Together, in this optimistic scenario, residues and unused offcuts could supply 1.3% of UK electricity. Because electricity is only one part of UK energy, this figure would equal roughly 0.5% of UK primary energy.

It is obvious, therefore, that the UK has limited supplies at best of low carbon, wood material from forests. As a result, virtually all increases in bioenergy will derive either directly from imports or through diversions of stemwood from other uses, which will indirectly result in further imports. Imported woody fuel material now comes in the form of wood pellets, which are constructed primarily of stemwood.[5] As discussed below, the potential supplies of residues to the UK even from Canada and the U.S. are extremely limited. These facts mean that unless DECC has clear rules restricting the types of biomass that will be treated as low carbon, the biomass actually used is unlikely to be low carbon.

3. **Although the UK Bioenergy strategy focused only on UK forests, papers analyzing other forest harvests come to the same conclusion, including uses of pine plantations in the southern U.S. and forest harvest thinnings.**

The supplemental statement notes that the UK Bioenergy Strategy only analyzed UK forests, and your blog particularly expresses hope that various "thinning" strategies or use of pine plantations in the southern U.S. for bioenergy might have different results. However, multiple peer-reviewed papers that have analyzed use of other forests for bioenergy have come to the same conclusion that the use of stemwood from whole trees will not result in GHG reductions for decades. See appendix for citations. At least one of these papers addressed loblolly pine plantations in the southern U.S., and it came to the same conclusion.[6]

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[5] This is shown in the report, Dogwood Alliance (2012), The use of whole trees in wood pellet manufacturing: Pictures and official descriptions of the use of whole trees by top wood pellet exports from the U.S. South to Europe.

[6] Mitchell, S., Harmon, M., K. O'Connell (2012), Carbon debt and carbon sequestration parity in forest bioenergy production, Global Change Biology 6:818-827. This paper analyzed bioenergy harvests from a broad range of potential forests and using a broad range of harvesting regimes. According to communication with the lead author, the loblolly pine forests would be simulated by the G1 and G2 scenarios, with G2 applying to heavily fertilized loblolly pine plantations.

Several papers have also analyzed the potential use of thinning strategies and come to the same conclusion. Perhaps the most promising thinning scenario would involve thinnings in fire-prone forests in the western U.S. because thinned material has some chance of otherwise burning even if not removed for bioenergy. Yet, several papers have found that even such thinning for fire purposes, coupled with use of such material for energy, did not reduce greenhouse gas emissions for decades.[7] In analysis for the State of Massachusetts, a team of researchers analyzed a potentially promising, if improbable, thinning scenario called "thinning from above." That thinning scenario would involve relatively rapid payback of harvested carbon because it involved the removal solely of mature trees, which had stopped growing, and that would allow light to penetrate into the forest to encourage growth by already established smaller trees. Yet even in that case, thinning resulted in no reduction in greenhouse gas emissions over 20 years.[8]

4. **The potential supply of wood products from U.S. or Canadian forests would also be limited.**

Accessing U.S. and Canadian potential supply does not substantially alter the potential contribution of wood to energy supplies. Table 4 below shows the maximum potential energy supply from wood residues using FAO data, assuming that potential residues equal 30% of all timber harvest. Such a scenario assumes that no tops and branches are left in the forest to maintain soil fertility or because they are impractical to gather. These residues could provide a maximum of 1% of U.S. primary energy, and 2.5% of Canadian primary energy. European supply could provide at most 1.6% of primary energy.

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[7] Hudiburg, T. et al. 2011. Regional carbon dioxide implications of forest bioenergy production, Nature Climate Change 1:419-423; J. Clark, J. Sessions, O. Krakina, T. Maness (2011), Impacts of thinnings on carbon stores in the PNW: A plot level analysis (College of Forestry, Oregon State University). It found that thinnings reduced carbon compared to leaving the forest alone over a period of 50 years.

[8] The analysis was presented Walker T. et al., 2010. Biomass sustainability and carbon policy study. Manomet Center for Conservation Sciences, Brunswick Maine. The State of Massachusetts incorporated the results into regulations analyzing the lifecycle emissions from the use of different forest products, and they are presented in a worksheet entitled MA RPS Regulation - Overall Efficiency and GHG Analysis Guideline DOER 081712, available at http://www.mass.gov/eea/energy-utilities-clean-tech/renewable-energy/biomass/renewable-portfolio-standard-biomass-policy.html. This worksheet does not indicate the full lifecycle analysis but measures how much carbon harvested by thinnings should "count" as an emission taking into account regrowth. It indicates that for a one-time operation, 88% counts, and for a continuous 20-year operation, 111% counts, i.e., the carbon cost is even greater than the actual emissions of carbon from the smokestack. The actual GHG performance replacing coal or natural gas is worse due to the reduced efficiency in the burning of biomass.

Indeed, as shown in Table 3, even if 100% of existing wood harvest were diverted away from wood products and to energy use from these regions, the energy supply would remain small. In the U.S., total wood harvest today would supply 3.4% of primary energy; and these figures would be 5.8% in Europe and 9% in Canada. To indicate the robustness of these results, Table 5 presents these numbers based on national datasets instead of FAO data, and the results do not substantially change.[9]

5. "Sustainable" forest management does not make biomass low carbon.

There are potential suggestions in your blog that moving to require forest management based on various forest certification criteria might assure that the use of the wood for bioenergy is low carbon. Although sustainable forest management is valuable in its own right, it has little to do with the carbon consequences of using wood for bioenergy. Regardless of the total volume of wood removed from forests, the critical factor for carbon accounting is the difference after the period of focus between the carbon stores in the forest subject to an additional harvest for bioenergy, and the carbon stores in that forest if not subject to that additional harvest. (Alternatively, if the wood would be harvested but used for another purpose, the critical question is the difference in greenhouse gas emissions that result in the use of that wood for fuel instead of some wood product.) For proof of this fact, DECC need look no farther than the UK Bioenergy Strategy. It calculates that the use of stemwood (except if otherwise wasted as discussed above) does not reduce greenhouse gas emissions although the Strategy indicates the department's belief that UK forests are sustainably managed.

I hope you will find this input useful.

Sincerely,

Timothy D. Searchinger

Cc: D. Mackay; NGOs

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[9] For example, the U.S. numbers are calculated using the latest estimates of wood harvest by the U.S. government of both soft and hardwood in B. Smith (2009), Forests of the United States, 2007 (US Forest Service, Washington); U.S. Forest Service conversion factors for volume to weight at Table 5, USDA, Specific Gravity and Other properties of Wood and Bark for 156 Tree Species Found in North America (2009), an energy content of 20 GJ per oven dry ton, and U.S. energy consumption from the U.S. Energy Information Agency.

Appendix

Table 1. What Percentage of UK Electricity and UK Primary Energy Could Its Wood Harvests Supply at 100% Use of Residues and 15% Use of Stemwood

UK Green Tonnes Annual Harvest (from Forest Research & North Energy, Carbon impacts of using biomass in bioenergy and other sectors: forests (DECC 2011) p. 16	**10,100,000**
CALCULATIONS OF QUANTITY ELECTRICITY PRODUCTION FROM UK WOOD HARVESTS	
Dry Tons (assuming green tons are 45% water)	5,555,000
Gigajoules per Dry Ton	20
Total energy contained in 100% of UK Wood harvests (in gigajoules)	111100,000
Total energy expressed in exajoules	0.11
Total energy when converted to electricity (in exajoules if converted at 30% efficiency)	0.03
Total energy in terrawatt hours (1 EJ = 277.8 TWH)	9.26
CALCULATIONS OF POTENTIAL SUPPLY OF UK ELECTRICITY BY PERCENTAGE	
Total UK Electricity Consumption in 2011 (from DECC Energy Consumption in the UK All-data Tables Terawatt Hours 2012 Update, Table 1.5 cell H50, downloaded from DECC website on November 25, 2012 http://www.decc.gov.uk/en/content/cms/statistics/publications/ecuk/ecuk.aspx)	318
Percentage of UK electricity if 100% of wood harvest used	2.91
Percentage of UK Electricity if 15% of wood harvest becomes otherwise unused off-cuttings	0.44
Percentage of UK Energy Supply	
UK Primary Energy Supply (in TWH from DECC publication above, Table 1.1, Cell D50)	2437
Total energy contained in 100% of UK wood harvests	30.86
Percentage of UK primary energy supply from 100% of annual UK forest harvest	1.27
Percentage of UK primary energy supply assuming use of 30% of residues plus 15% of annual UK forest harvest assumed to be unused off-cuttings	0.57

Table 2 – Differential Results of Using Biomass Reproduced from UK Bioenergy Strategy, copied from supplementary note of November 22, 2012

Group No	Mean relative emissions (t CO_2-eq ha^{-1} yr^{-1}) 20/40 year time horizon	Mean relative emissions (t CO_2-eq ha^{-1} yr^{-1}) 100 year time horizon	Scenario	Scenario forming group: Sawlogs Main	Sawlogs Off-cut	Small Roundwood Main	Small Roundwood Off-cut	Bark	Branchwood (50%)
1	-68	-54	04	Sawn timber	Particleboard	Particleboard		Fuel	Fuel
2	-56	-45	10	Sawn timber	Particleboard	Pallets	Particleboard	Fuel	Fuel
			16	Sawn timber	Particleboard	Fencing	Particleboard	Fuel	Fuel
3	-45	-36	03	Sawn timber	Fuel	Particleboard	Particleboard	Fuel	Fuel
			05	Sawn timber	Particleboard	Fuel	Fuel	Fuel	Fuel
			15	Sawn timber	Particleboard	Fencing	Fuel	Fuel	Fuel
			17	Sawn timber	Particleboard	Fuel	MDF	Fuel	Fuel
			22	Sawn timber	Particleboard	Paper & card	Paper & card	Fuel	Fuel
4	-32	-26	13	Sawn timber	Fuel	Fencing	Particleboard	Fuel	Fuel
			19	Sawn timber	MDF	Fencing	Particleboard	Fuel	Fuel
5	-21	-17	02	Sawn timber	Fuel	Fuel	Fuel	Fuel	Fuel
			06	Sawn timber	Fuel	MDF	MDF	Fuel	Fuel
			07	Sawn timber	MDF	MDF	MDF	Fuel	Fuel
			08	Sawn timber	MDF	Fuel	Fuel	Fuel	Fuel
			09	Sawn timber	Fuel	Pallet	Fuel	Fuel	Fuel
			11	Sawn timber	MDF	Pallet	MDF	Fuel	Fuel
			12	Sawn timber	Fuel	Fencing	Fuel	Fuel	Fuel
			14	Sawn timber	Fuel	Fencing	MDF	Fuel	Fuel
			18	Sawn timber	MDF	Fencing	Fuel	Fuel	Fuel
			20	Sawn timber	MDF	Fencing	MDF	Fuel	Fuel
			21	Sawn timber	Fuel	Paper & card	Paper & card	Fuel	Fuel
			23	Sawn timber	MDF	Paper & card	Paper & card	Fuel	Fuel
6	- 7	-7	01	Fuel		Fuel		Fuel	Fuel

Table 3: Wood Production and Potential Energy Supply Using FAOSTAT Data by Country or Region				
	Canada	European Union	United States of America	World
Item				
Roundwood (cubic meters)	135,655,250	412,879,661	340,363,718	3,403,189,709
Roundwood (Coniferous) (cubic meters)	111,106,615	281,991,856	207,664,423	1,134,700,239
Roundwood (NonConiferous) (cubic meters)	24,548,636	130,887,805	132,699,296	2,268,489,470
Wood Residues (cubic meters)	8,774,000	44,200,075	13,875,000	130,170,948
Oven-dry Roundwood in tonnes[1]	58,503,755	184,352,975	154,751,809	1,652,781,791
Exajoules of Roundwood	1.17	3.69	3.10	33.06
Primary Energy Consumption in Exajoules	13.8	70.8	95.0	513.9
Percent Roundwood is of Primary Energy	8.5%	5.2%	3.3%	6.4%
Oven-dry Wood Residuals (FAO definition of residues)	3,783,945	19,735,570	6,308,491	63,218,389
Exajoules of residual wood[2]	0.1	0.4	0.1	1.3
Percent Wood Residuals is of Primary Energy	0.5%	0.6%	0.1%	0.2%
Percent Total Wood (roundwood plus residuals) of Primary Energy Consumption	9.0%	5.8%	3.4%	6.7%
Electricity Consumption KWH	549,500,000,000	3,037,000,000,000	3,741,000,000,000	19,010,000,000,000
Total Electricity Consumption in Exajoules[3]	2.0	10.9	13.5	68.4
Percent of Electricity Consumption 100% of Wood Harvest Could Supply[4]	15.7%	9.3%	6.0%	12.5%

Sources: Roundwood and Wood Residue volumes are 2008-2011 FAOStat Forestry Production data; Primary energy consumption is BP Statistical Review of World Energy June 2012 bp.com/statisticalreview; Electricity consumption is CIA World Factbook https://www.cia.gov/library/publications/the-world-factbook/rankorder/2042rank.html#top

[1]Conversion of wood volumes to oven-dry equivalents is .411 tonnes oven-dry to tonnes green for coniferous and .523 tonnes oven-dry to tonnes green for hardwood, Table 5, USDA, Specific Gravity and Other properties of Wood and Bark for 156 Tree Species Found in North America (2009)

[2]Conversion of wood tonnage to energy is 20 tonnes per gigajoules and 1,000,000,000 gigajoules per exajoule.

[3]Conversion of kWh is 1 kilowatt hour = 3.6 × 10^-12 exajoules

[4]Conversion of Wood to electricity is at 25% efficiency

Note that wood residueal as reported by FAO are not all tops and branches that may supply potential residues. It mainly includes wood processing residues. http://www.fao.org/forestry/statistics/80572/en/

Table 4: Maximum Potential Energy Production from Potential Wood Residues (tops and branches) Using FAOSTAT Data				
	Canada	European Union	United States of America	World
Item				
Potential total wood residues (30% of round wood) cubic meters	40,696,575	123,863,898	102,109,115	1,020,956,913
Oven-dry Wood Residues (tonnes)	17,551,126	55,305,892	46,425,543	495,834,537
Exajoules of Wood Residues	0.4	1.1	0.9	9.9
Primary Energy Consumption	13.8	70.8	95.0	513.9
Percent Wood Residue is of Primary Energy	2.5%	1.6%	1.0%	1.9%
Electricity Consumption KWH	549,500,000,000	3,037,000,000,000	3,741,000,000,000	19,010,000,000,000
Electricity Consumption in Exajoules	2.0	10.9	13.5	68.4
Percent Maximum Residue is of Electricity Consumption at 25% Conversion Efficiency	4.4%	2.5%	1.7%	3.6%

Note: This analysis assumes that for each tonne of wood harvest, 0.3 tonnes of tops and branches are available to be harvested as residues

Table 5—Maximum Energy Production from Wood Harvests Using Nationally Generated Data

	U.S. (2007)	Canada (2010)	EU-27 (2008)
Roundwood (softwood), cubic meters	281,704,006	185,000,000	278,296,000
Roundwood (hardwood), cubic meters	142,768,657	57,000,000	132,939,011
Oven-dry roundwood, tonnes[1]	190,019,149	105,846,000	183,906,759
Oven-dry roundwood, exajoules[2]	3.8	2.1	3.7
Primary energy, exajoules	103.6	14.6	70.8
Percent Roundwood is of Primary Energy	3.7%	14.5%	5.2%
Maximum Potential Oven-dry Logging Residues, tonnes	59,863,688	12,853,000	8,240,961
Maximum potential logging residues, exajoules	1.2	0.3	0.2
Percent Logging Residues are of Primary energy (assuming wood used at the same efficiency as fossil fuels)	1.2%	1.8%	0.2%
Percent Roundwood and Logging Residues are of Primary Energy	4.8%	16.3%	5.4%
Electricity Consumption, exajoules	13.5	2.0	10.9
Percent 100% of Roundwood and 100% of Logging Residues Could Supply of Electricity Consumption[3]	9.3%	30.0%	8.8%
Percent 100% of Logging Residues Could Supply of Electricity Consumption[3]	2.2%	3.2%	0.4%

Sources: Rounwood and Wood Residue volumes are Table 41, Forest Resources of US. 2007, USFS p. 290, National Forestry Database, Potential Harvest/Allowable Annual Cut for Canada, 1957-2010 (Millions of cubic metres) http://nfdp.ccfm.org/supply/background_e.php , and EUROSTAT Forestry Statistics 2009, Roundwood Production, 2009, p. 46 http://epp.eurostat.ec.europa.eu/cache/ITY_OFFPUB/KS-78-09-993/EN/KS-78-09-993-EN.PDF ; Wood residues are Table 41, Forest Resources of US. 2007, USFS p. 291, Canada- Sustainable Forest Biomass Supply Chains, Oct 19, 2007, p. 8 Roadside oven dry tonnes of slash For IEA Task 40, Douglas Bradley, President,Climate Change Solutions http://www.canbio.ca/upload/documents/sustainableforestsupplychainsoct192007.pdf , and ECE/TIM/DP/49, Timber Section, Geneva, Switzerland, GENEVA TIMBER AND FOREST STUDY PAPER 51, CURRENT WOOD RESOURCES AVAILABILITY AND DEMANDS, NATIONAL AND REGIONAL WOOD RESOURCE BALANCES, EU/EFTA COUNTRIES By Florian Steierer http://www.unece.org/fileadmin/DAM/timber/publications/DP-51_for_web.pdf ; Primary energy consumption is BP Statistical Review of World Energy June 2012 bp.com/statisticalreview; Electricity consumption is CIA World Factbook https://www.cia.gov/library/publications/the-world-factbook/rankorder/2042rank.html#top

[1]Conversion of wood volumes to oven-dry equivalents is .411 tonnes oven-dry to tonnes green for coniferous and .523 tonnes oven-dry to tonnes green for hardwood, Table 5, USDA, Specific Gravity and Other properties of Wood and Bark for 156 Tree Species Found in North America (2009)

[2]Conversion of wood tonnage to energy is 20 tonnes per gigajoules and 1,000,000,000 gigajoules per exajoule.

[3]Conversion of Wood to electricity is at 25% efficiency

Papers Analyzing Carbon Payback Times for Wood Harvest

Bernier, P., Pare D. (2012), Using ecosystem CO2 measurements to estimate the timing and magnitude of greenhouse gas mitigation potential of forest bioenergy, Global Change Biology Bioenergy (advance online publication July 16, 2012) DOI: 10.1111/j.1757-1707.2012.01197.x;

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