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Mobile Applications to Link Sustainable Consumption with Impacts on the Environment and Biodiversity

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Ethical consumption is becoming increasingly important to reconcile global agricultural production and biodiversity conservation. Smartphones equipped with sustainability applications ("apps") could help connect consumer decisions with their environmental and biodiversity impacts. We review the existing apps for sustainable consumption to assess their transparency, their authoritativeness, whether the connections between consumption and biodiversity impacts are available to consumers, and whether sustainability ratings are consistent. We found 32 apps that met our search criteria. Food and service products were the most commonly assessed, the sustainability assessment criteria were not publicly accessible for half of the apps, and few links between consumption and biodiversity conservation were made. An ideal app would need to overcome the currently scarce official authoritativeness and use transparent and objective sustainability ratings. The potential of mobile apps for conservation is large and untapped, representing an alternative to supplier-focused, on-the-ground interventions.

Keywords: certification, ethical consumption, green labels, tropical deforestation

As the world population continues to grow unabatedly in this century, it is expected that by 2100, there will be 10.9 billion people sharing the limited resources of our planet (Gerland et al. 2014). The aggregate resource consumption of humanity is the driver of the current biodiversity crisis (Oskamp 2000, Butchart et al. 2010), as is manifested in the unprecedented high extinction rate of species (De Vos et al. 2014). Besides human population increases, changes in household dynamics have led to an increase in the number of households globally, resulting in higher *per capita* resource consumption (Liu et al. 2003).

The consumers' part in reconciling agricultural production, environmental impacts, and biodiversity conservation, however, has been less explored by conservation scientists and in the international policy arena compared with other market-based instruments. With the exception of Agenda 21 in the 1992 Rio Earth Summit, sustainable consumption has not been embraced by major international strategies (Seyfang 2005). Such underemphasis on this approach is paradoxical given the large impact that consumer behavior can have on the way businesses are conducted. Some examples of the power of the public when used *en masse* are the public boycott triggered by a footage of dolphins killed in tuna nets that converted the US tuna market into a dolphin-safe one instantly (Baird and Quastel 2011) or the massive online public outcry in Vietnam over the torture of endangered monkeys that resulted in unprecedented disciplinary actions (Nghiem et al. 2012).

Because the globalization of agricultural supply shifts the production model into one dominated by multinational companies, consumer behaviors are increasingly relevant as a potential solution to mitigate the global sustainability crisis. For example, deforestation in Southeast Asia is no longer driven by subsistence slash-and-burn smallholders but mostly by large corporations for oil-palm production, pulp, and paper (Lee et al. 2014). This trend is also apparent in Africa, where new agricultural companies are starting to invest heavily (Carrasco et al. 2014). Agribusiness multinational companies need to be responsive to the concerns of consumers, NGOs, and investors globally. This is exemplified by the recent zero-deforestation pledges of oil-palm, pulp, and paper companies in Indonesia leading to the High Carbon Stock approach and the Sustainable Palm Oil Manifesto (Pirard et al. 2015). In general, *ethical consumption*, or making purchasing choices based on ethical, social, economic, and environmental considerations, is increasingly

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seen as a route to a sustainable future (Rex and Baumann 2007). In a broader context, political consumerism as a way of expressing one's political stance through choices of producers and products has been gaining momentum, especially among the youth via online platforms (Ward and de Vreese 2011).

To practice ethical consumption, consumers need to overcome information asymmetries in the market (Upham et al. 2011). Ecolabeling is intended as a tool to inform consumers about the environmental performance of the products offered, thereby navigating them to the products that match their ethical concerns (Ibanez and Grolleau 2008). This market is significant at present, with the eco-certified forest and agricultural products market amounting to over $47 billion annually (Milder et al. 2010).

Imperfect knowledge stems not only from information asymmetries in the market but also from the rise of vertical specialization among countries in different stages of manufacturing processes (Hummels et al. 2001). Consequently, individual end users are physically and emotionally detached from the environmental repercussions of their purchasing decisions. For example, it would be a challenge for a layman residing in the United States to link the decision to buy toothpaste of a certain brand to biodiversity declines in Indonesia. It is now evident that oil-palm production, which provides palm oil as a component in most toiletries, is a major driver of deforestation in Southeast Asia (Fitzherbert et al. 2008, Wilcove and Koh 2010).

New Internet-related technologies may present an opportunity to increase the awareness of global environmental problems (Papworth et al. 2015). Specifically, smartphone applications ("apps") offer multiple possibilities for individuals to assess the links between behavior and welfare (e.g., physical activities and prescription for health promotion; Knight 2014) or to link individuals and science (e.g., citizen science to report the detection of invasive species; Graham et al. 2011). Mobile apps that link consumption to impacts on biodiversity could provide a way to inform consumer purchasing choices in real time and immediate reinforcement for sustainable consumption.

Despite the potential of ecolabeling and the use of smartphone apps in incentivizing consumer practices that favor the conservation of biodiversity, there is little research done in this area. A search of scholarly publications in the last 10 years in Web of Science with the keyword "ecolabel*" resulted in 150 publications, of which only 2% were in the field of biodiversity conservation (Nunes and Riyanto 2005, Kaiser and Edwards-Jones 2006, Blackman and Rivera 2011). To help fill this knowledge gap, we (a) review the existing sustainability consumption apps to assess their authoritativeness, transparency, and whether the connections between personal consumption and pressure on the environment and biodiversity are available to consumers and (b) assess the consistency in sustainability ratings among these apps.

Sustainable consumption mobile apps

We limited the review to apps that informed end consumers on the sustainability of their purchasing options. Apps that informed users of the ecological impacts of their activities that did not involve purchases (e.g., providing tips to save water or energy or to reduce household waste) were excluded.

We performed a systematic review of English-language apps in the Apple and Google Play stores, following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (figure 1; Moher et al. 2009). We limited our search to the virtual stores in the United States, the United Kingdom, and Australia. All searches and the review of apps contents were conducted from 27 July 2015 to 15 August 2015. We used the keywords "sustainable" or "ethical," leading to 705 potentially relevant apps. Apps were limited to the following categories: *lifestyle*, *reference*, *education*, *health and fitness*, and *food and drink* in the Apple store and *lifestyle*, *shopping*, *book and reference*, *education*, and *tools* in the Google Play store. This search was complemented by a separate screening of the 310 global sustainability apps amassed by the US Environmental Protection Agency (*www.epa.gov/mygreenapps/index.html*). When we combined both searches, 25 relevant apps were identified. We performed a second screening of the apps related to these 25 apps using the *customers also bought* and *similar* sections in iPhone and Android, resulting in 7 additional apps included in the review. In total, 32 apps were selected (figure 1).

Apart from using the data provided in the app descriptions, we conducted a separate scan of the app developers' websites that were publicized in the stores to verify the information or functions offered in the app: (a) types of products assessed, (b) properties of the product promoted by the app, (c) whether the standards/rating schemes and the assessment procedure were explicitly publicized and whether the producer was involved in the assessment, (d) how the assessment results were presented to the apps users, and (e) whether environmental indicators or biodiversity impact indicators were incorporated in the assessment criteria/standards.

We compared the sustainability ratings of the apps for the global top 30 consumer house brand companies (Deloitte 2015). Only three of the selected apps—*The Good Shopping Guide*, *Climate Counts*, and *Shop Ethical*—produced sustainability ratings of the selected brands. A second comparison was conducted on the apps that ranked the sustainability of seafood, which was found to be the most popular product type. Because fish species can be referred to by various common names in different localities, we limited the comparison to three apps—*Good Fish Guide*, *Planet Ocean*, and *WWF Sassi*—that provided rankings based on the scientific names of fish species. To ensure the accuracy of the comparisons, we removed the species that had multiple rankings in the same app (as a result of different origins and fishing methods). A total of 100 species were assessed, and only those

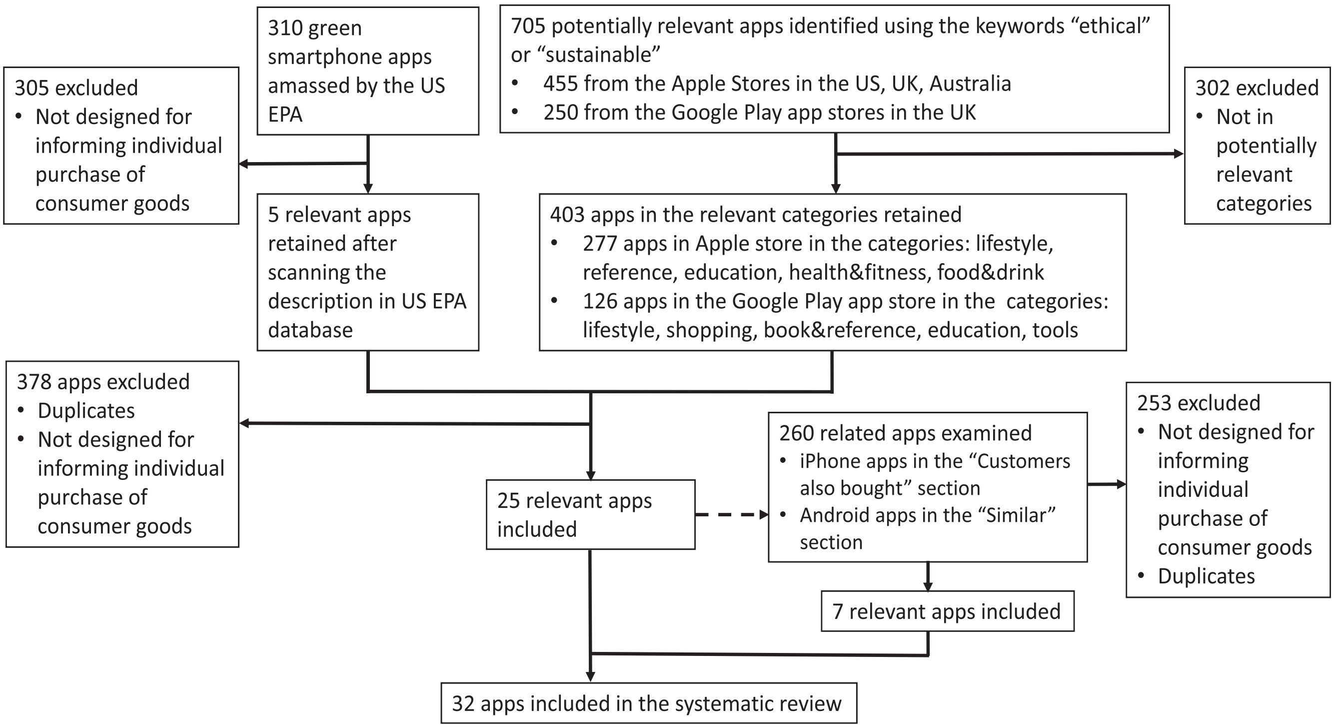

Figure 1. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flowchart of the study selection.

that appeared in at least two apps were considered, leading to 21 common species.

We performed ANOVA and Pearson correlation tests to assess the consistency between the sustainability scores or rankings. To be able to perform the correlation tests on categorical variables, the function "as.numeric()" was employed in the R environment to convert categorical variables into numerical variables. For instance, categorical levels B, C, D, and F in the app *Shop Ethical* (table 1) were converted to 1, 2, 3, and 4.

Characteristics of the selected sustainability apps

We found 32 apps that met our search criteria in the smartphone stores of Apple and Android platforms, of which 29 and 24 were available in the Apple and Android platforms, respectively. Except for *The Good Shopping Guide* ($4.99 in the Apple store, unavailable in the Google Play Store) and *Shop Ethical* ($3.99 and $6.09 in the Apple and Google Play stores, respectively), all apps were downloadable free of charge. The apps with the lowest and highest estimates of downloads for Android-based (this metric is not publicized in Apple stores) devices were *EcoDirectory Australia* (50–100 downloads) and *Seafood Watc*h (100,000–500,000 downloads), respectively (supplemental table S1 lists the characteristics extracted from the apps).

Of the 32 apps, 20 (63%) specialized in a specific type of product/service: food products (5 apps), seafood (8 apps), restaurants (4 apps), tissue paper (*Tissue Guide*), ornamental fish (*Tank Watch: Good Fish/Bad Fish*), and cosmetics (*Bunny Free*). Twelve apps (37%) assessed multiple types of products, mainly food, cosmetics, and household products (figure 2d). Across all apps, food products and services were the most commonly assessed (26 apps, 81%). Other products assessed included cosmetics/personal care (8 apps), household products (8 apps), fashion, and travel (e.g., airlines, hotels).

The products promoted in the apps were assessed using sustainability indictors that could be classified in two main groups: ethical and social (16 apps) and/or environmental (25 apps). All apps described qualitatively the sustainability indicators employed. Among ethical and social indicators, the description encompassed products not tested on animals (5 apps, e.g., *Bunny Free*, *Cruelty Free*), products conforming to fair-trade standards (3 apps, e.g., *The Good Shopping Guide*), companies against price fixing, companies encouraging local and/or organic products, the fair treatment of workers, companies against genetically modified organisms, and socially responsible products. Ethical and social indicators were associated with nonfood products (figure 2d). Among environmental sustainability indicators, these included products from sustainably managed fish stocks or farms, that promoted conservation of tropical forests (3 apps), that minimized impacts on marine life and coral reefs, that reduced greenhouse gas emissions, that promoted recycling, and that minimized harmful chemicals (table S1).

We were unable to access online the standards/rating schemes of 20 apps (62.5%) and the specific description of the assessment procedure for 23 apps (72%). For 17 apps (53%), neither standards/rating schemes nor assessment

Table 1. The sustainability rankings of the top 30 household brands in The Good Shopping Guide, Climate Counts, and Shop Ethical apps.

Company name	The good shopping guide	Climate counts	Shop Ethical	Company name	The good shopping guide	Climate counts	Shop Ethical
Nestlé	40–54	80	F	Diageo	36	na	C
P&G	20–38	59	F	Reckitt Benckiser	54	85	C
PepsiCo	40–56	75	F	Kellogg	60	61	F
Unilever	43–63	91	C	Kao	54	na	C
Coca-Cola	32	85	F	H. J. Heinz	52	na	C
Anheuser-Busch	na	65	F	Estée Lauder	54	na	F
Mars	35	na	F	Ferrero	65	na	C
L'Oréal	46	87	F	Avon	50	73	D
Danone	52	85	D	Campbell Soup	48	na	C
Heineken	56	79	D	Dr Pepper Snapple	68	na	D
Kimberly-Clark	na	69	C	Clorox	na	77	D
Kraft Foods	na	74	F	Energizer	81	na	B
General Mills	40	62	C	Barilla	68	na	C
Colgate-Palmolive	54–62	71	C	Molson Coors Brewing	56	74	na
SABMiller	na	61	C	LG	67	83	C

Note: On a scale from 0 to 100, higher numeric scores indicate more sustainable products; on the scale from B to F, letters earlier in alphabetical order indicate more sustainable brands. Abbreviation: na, nonapplicable or missing information.

procedures were available (figures 2c and 2d). Only six apps (19%) explicitly publicized both their standards/rating schemes and assessment procedures. In contrast, all apps except *EcoDirectory Australia* presented sustainability rating results in scores, categories, or (locations of) recommended businesses/brands.

Eleven apps (34%) provided binary output information, such as whether the product was sustainable in a certain aspect (e.g., whether it contained palm oil; *Palm Oil Shopping Guide*, *Palm Oil Guide and Scanner*) or whether it was accredited by the app developer (*Choose Cruelty Free*). Eleven apps (34%) presented sustainable assessments in an ordinal scale, mostly using the traffic-light system, in which red, amber, and green were respectively associated with bad, average, and good practices (figure 2b). Four apps (*Climate Count*, *Ethical Barcode*, *GoodGuide*, *The Good Shopping Guide*) assigned explicit "sustainable scores" to the assessed products. Scores were more commonly associated with food-related products (figure 2b). Five apps (*Abdubon Gulf Seafood Guide, Conscious Consumers*, *Cruelty-Free*, *Ethical Eats!*, *Noshplanet*) specialized in presenting to users their recommended businesses/products. *EcoDirectory Australia* was the only app providing general information about the products. Six apps also incorporated a navigation function for users to locate their recommended businesses (mostly restaurants) or provided users with a list of their "best" or "partner" brands besides giving ratings of other brands (figure 2d). In total, 11 apps (34%) had the capability to function as a marketing platform for businesses. Of these 11 apps, only *Certified Humane* and *Non-GMO Project Shopping Guide* explicitly publicized both their standards/rating schemes and assessment procedure (figure 2d). In these two cases, the app developers function as certifying organizations that liaise with the businesses who apply to get their products/services accredited. This could explain the association between public sustainability criteria and the advertising of other products (figure 2a).

To identify which specific connections with biodiversity impacts are present in the development of the available apps, we examined the available rating schemes and found that only 5 apps (*Audubon Gulf Seafood Guide*, *GoodGuide*, *Seafood Finder*, *Seafood Watch*, and *Sustainable Seafood Guide*) incorporated considerations of impacts on biodiversity. Except for *GoodGuide*, the specific conservation-related rating criteria were focused on marine ecosystems. Other apps, such as *Palm Oil Shopping Guide*, that focused on the conservation of tropical forests and forest-dwelling species (e.g., the orangutan) had unavailable rating criteria.

Consistency in apps' scores

We found both consistencies and inconsistencies in the ranking of sustainability between brands (table 1). In the analysis of household brands, *Climate Counts* ranked most brands favorably, whereas the other two apps appeared to apply stricter standards and therefore gave different ratings for most brands. Using Pearson's correlation tests, we found no

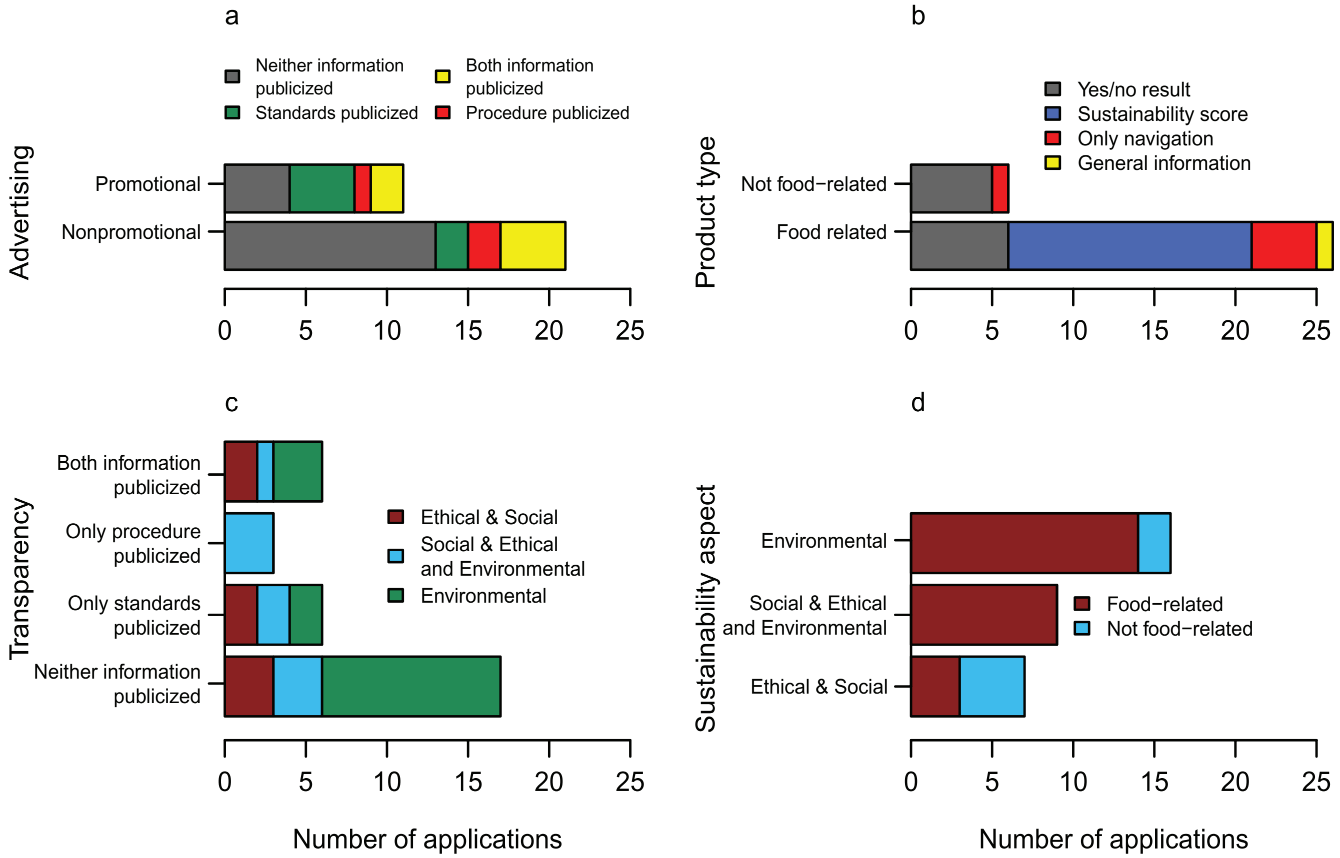

Figure 2. Characteristics of sustainable consumption apps: (a) whether the apps have advertising features (promotional or nonpromotional) versus their level of transparency (whether the sustainability standards/rating schemes and/or the assessment procedures are publicly accessible); (b) the type of products assessed (whether or not food related) in the apps versus the presentation of sustainability rating (whether the products are sustainable or not, what is the sustainable score/rating of the product, navigation to the recommended products/businesses, and general information on the product); (c) the level of transparency versus the type of sustainability indicators assessed (ethical and social and/or environmental indicators); and (d) the type of sustainability indicators assessed versus the type of products assessed.

correlation between the scores for *The Good Shopping Guide* and *Climate Counts* (correlation coefficient = 0.22, $p = 0.43$). Converting the scores of *Shop Ethical* into a numeric scale and running correlation tests showed a significant negative correlation with *The Good Shopping Guide* (correlation coefficient = –0.51, $p < 0.01$, which would also be significant under a Bonferroni correction for multiple comparisons). In this case, this result indicates consistent scores because *Shop Ethical* follows the alphabetical order (e.g., B is more sustainable than C; table 1). We found no correlation, however, with *Climate Counts* (correlation coefficient = –0.06, $p = 0.79$). These results were corroborated with ANOVA tests in which the scores by *Shop Ethical* were kept as categorical (scores C, D, and F presented coefficients of –27, –25 and –37, with $p < 0.05$ when *The Good Shopping Guide* was used as dependent variable).

We found score consistency between the rankings of fish species in the three different apps assessed, even though the number of species that were commonly assessed in multiple apps were low: 14 mutual species between *WWF Sassi* and *Planet Ocean*, 7 mutual species between *Good Fish Guide* and *Planet Ocean,* and only 2 mutual species between *WWF Sassi* and *Good Fish Guide* (table 2). The scores from the apps ("green", "yellow," and "red") were converted to a numerical scale, and correlation tests showed a marginally significant correlation between *Good Fish Guide* and *Planet Ocean* (correlation coefficient = 0.73, $p = 0.062$) and a significant positive correlation between *WWF Sassi* and *Planet Ocean* (correlation coefficient = 0.82, $p = 0.0003$).

Discussion

Our review of sustainable consumption apps showed several patterns. We found that apps mostly focused on food-related purchases. This agrees with the salience of conflicts between global food consumption and the conservation of natural resources or sustainable usage (Tscharntke et al. 2012). Especially common were apps informing of sustainable fish and seafood consumption, which reflects how the fish stock in all the oceans has suffered dramatic declines since the onset of industrialized fishing (Myers and Worm 2003).

Table 2. The sustainability rankings of common fish species in the apps Good Fish Guide, Planet Ocean, and WWF Sassi.

Species name	WWF Sassi	Planet Ocean	Good Fish Guide
Clupea harengus	green	green	na
Crassostrea gigas	green	green	na
Jasus lalandii	yellow	green	na
Merluccius capensis	green	green	na
Mytilus galloprovincialis	green	green	na
Oncorhynchus gorbuscha	green	green	na
Oncorhynchus keta	green	green	na
Oncorhynchus kisutch	green	green	na
Oncorhynchus nerka	green	green	na
Oncorhynchus tshawytscha	green	green	na
Pandalus borealis	yellow	green	na
Penaeus monodon	yellow	yellow	na
Scomber scombrus	green	green	na
Thunnus thynnus	red	red	red
Thunnus albacares	green	na	yellow
Chelidonichthys lucerna	na	yellow	yellow
Conger conger	na	yellow	red
Coryphaenoides rupestris	na	red	red
Hoplostethus atlanticus	na	red	red
Loligo vulgaris	na	yellow	yellow
Macrourus berglax	na	red	red

Note: The green, yellow, and red categories denote good, acceptable, and bad choices, respectively. **Abbreviation:** na, nonapplicable or missing information.

We found that a substantial proportion of the apps (28%) suggested businesses to users, showing the potential of the apps to consumers' decisions. This could be a form of advertising and a potential way to fund app development, provided that ethical issues related to conflict of interest can be avoided. Although such a promotional feature of apps could function as a reference to encourage the purchases from sustainable businesses/brands, the recommendations should ideally result from verifiable and transparent criteria. In this respect, one main finding of our study is how infrequently the app developers publicize their assessment processes. Such a practice may have resulted from the lack of regulation on the apps. For example, except for *Ethical Eats!*, which was funded by the Canada's Department of Foreign Affairs, Trade, and Development, none of the apps were explicitly declared to be developed by a public authority.

Using transparent and reliable sustainability criteria is important because sustainability ratings have been shown to encourage good practices by sustainable companies because consumers tend to perceive the advertisements of companies with high sustainability ratings as genuine (Parguel et al. 2011). Given that even the most conscientious consumers often lack the time to conduct research and interpret the sustainability information presented to them (Young et al. 2010), authoritative ratings would be a solution to offer consumers a simple and quick way to make purchasing decisions.

Without an institutional framework to regulate the information provided by sustainability apps, consumers need to navigate through unverified and even possibly conflicting information, resulting from the unstandardized assessment procedures conducted by different app developers. Ideally, an app developed in affiliation with internationally recognized authorities (such as The Forest Stewardship Council, The Marine Stewardship Council, or organizations from the United Nations) would convey a sense of reliability and credibility to consumers.

Despite the prevalence of nontransparent sustainability criteria in the apps, we found consistent scores in the sustainability rankings of common household brands in two out of three apps analyzed and consistent scores in the three fish species apps analyzed. The ranking in the fish sustainability apps showed consistency, but this was limited to a few apps and products given the small overlap between products assessed. This correlation could be explained by the specificity of product type (seafood), which results in similar sustainability standards (environmental aspects only) regarded by the apps. The discrepancies in ranking household brands found in three of the apps studied could be attributed to the different sustainability standards employed by the apps. For example, *Climate Counts* focused only on some environmental aspects of sustainability (greenhouse gas emissions), whereas the other apps also included ethical and social standards in their assessments. Similarly, the wide range of sustainability indicators considered by the apps presented low overlap in environmental and social and ethical indicators, denoting the lack of a common sustainability framework used to guide the evaluation criteria.

Among the sustainability indicators, we found a very low inclusion of biodiversity impacts criteria in the apps, making the link between consumption and damages to biodiversity unlikely for app users. This low prevalence may be the result of the complex relationships between consumption and biodiversity (Lenzen et al. 2012). This is compounded by the paucity of modeling platforms to translate consumption into land-use, habitat-loss, and eventually biodiversity threats. Although we do not currently have the systems in place to link, in real time, the effects of consumption on biodiversity, recent technological advances in satellite image analysis and information technologies could make this possible in the near future. For instance, illegal deforestation is increasingly monitored in real time through projects such as Terra-i (with updates every 16 days; *www.terra-i.org*) or Global Forest Watch from the World Resources Institute (*www.globalforestwatch.org*). Global Forest Watch is indeed actively used to monitor forest fires in Indonesia and to link fires to agribusiness companies' concessions. Once the links among companies, deforestation, and land use are established, species-distribution and richness maps (e.g., Butchart et al. 2010, Jenkins et al. 2013) can be used within species–area relationship models (e.g., Brook et al. 2003). This combination can ultimately link companies' activities with increases in the extinction risk of specific endangered species. The experience with Global Forest Watch and its own app, which allows the mapping and reporting of illegal deforestation-related activities, shows that such models and links could be developed. If this real-time information is further combined with the barcode-scanning capabilities already present in some apps, consumers would be able to discriminate between products in a matter of seconds at supermarkets. The development and implementation of such models would be complex but could be achieved with an interdisciplinary team encompassing remote-sensing experts, agricultural product–traceability experts, land-use and ecological modelers, international-trade modelers, and computing and database experts.

Information on biodiversity impacts on the apps may, however, necessarily be technical, which may be difficult to convey in a simple manner understandable by the general public. Further research would be needed to assess whether technical biodiversity impacts information may discourage app users or, by contrast, help raise awareness about biodiversity conservation. Similarly, it would be useful to assess which environmental sustainability indicators are more easily communicated to the public and more effective at promoting sustainable consumption.

Sustainability apps could also leverage the power of social media to involve more consumers. One of the main criticisms of sustainable consumption is the solitude of purchases. This stems from the powerlessness sentiment that one's isolated actions are insufficient to generate a noticeable change (Seyfang 2005). Such disconnectedness can be remedied by an interactivity component in the apps, such as allowing users to link their sustainability purchasing history to their social-media accounts (e.g., Facebook, Twitter), which might encourage peers to behave sustainably (Toner et al. 2014). Promoting a sustainable lifestyle via social media could contribute to breaking inertia, which is one of the main obstacles to behavioral change toward a sustainable lifestyle (Oskamp 2000). To attain this, the apps could, for instance, report the aggregate effect of all the users or Facebook friends using the app, creating a sense of community pursuing a common goal.

Another area of potential improvements would be to learn from weight-loss apps, in which specific budget and goals can help motivate users. It has been shown that behavioral change is more likely if individuals can foresee the specific steps needed to attain a sustainable lifestyle (Oskamp 2000). For example, an app could offer a "sustainability budget" or a comparison with the average consumer as a baseline to which the footprint of the user's purchase is added. This might encourage the user to switch to a more sustainable diet for certain meals, such as eating chicken instead of beef, to offset the impact of previous high-impact purchases. Another potential application of the apps would be to draw on the concept of crowdfunding integrated into sustainable purchases. This could allow consumers to choose to pay a premium that can contribute to conservation projects related to the production of the items purchased. Linking crowdfunding with payment-for-ecosystem-services schemes and to fund biodiversity conservation work has started to be explored (Dinerstein et al. 2013, Gross 2014, Veríssimo and Pais 2014). An example is the app *Palm Oil*, which includes a donation option. Smartphone apps can thus be used as a novel avenue to remotely fund conservation interventions on the ground.

Conclusions

In an increasingly hyperconnected world, sustainability smartphone apps have the potential to increase the feedback from distant consumers around the globe on the stewardship of natural resources. Novel approaches to tackle global environmental problems and declines in biodiversity are needed (Tittensor et al. 2014), and consumer-based approaches could complement on-the-ground, supplier-based approaches. Sustainability smartphone apps introduce a novel pathway to help consumers visualize the environmental consequences of their personal purchases, thereby reducing the characteristic information asymmetry in consumer markets (Watts 2011).

The potential of sustainable consumption apps is nonetheless poorly explored and untapped. Although two out of three and three out of three apps show consistency in the score ratings of household brands and fishes, respectively, we have shown that current apps, in general, lack authoritativeness and transparency and rarely include biodiversity impacts in their criteria. An authoritative app with extensive information to create a link from satellite images to companies, with environmental and biodiversity impacts, while also generating peer pressure in social media could be very effective in modifying unsustainable consumer and producer behaviors. Although such an app would be an ambitious project, the rapid rate of habitat loss, especially in the tropics, and the limited success of on-the-ground conservation interventions should, more than ever, urge conservation scientists to explore the potential of mobile apps for sustainable consumption.

Supplemental material

The supplemental material is available online at *http://bioscience.oxfordjournals.org/lookup/suppl/doi:10.1093/biosci/biw016/-/DC1*.

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