

RESEARCH ARTICLE

The winners and losers in the race to environmental sustainability: a ranking of Summer Olympic International Federation progress [version 1; peer review: 1 approved with reservations]

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V1 First published: 07 Jul 2021, 3:12
<https://doi.org/10.35241/emeraldopenres.14195.1>
Latest published: 07 Jul 2021, 3:12
<https://doi.org/10.35241/emeraldopenres.14195.1>

Abstract

Purpose: The purpose of this paper is to consolidate knowledge and benchmark the progress being made across the 32 International Federations (IFs) in the Summer Olympic Programme.

Design/methodology/approach: A website content analysis, analytical hierarchy of information, and social media research was conducted to triangulate the barriers and drivers of environmental sustainability (ES) progress. This data was then analysed to empirically substantiate the findings of previous methods by exploring potential drivers of IF ES progress and communication and refining the ranking of IF ES progress.

Results and findings: World Sailing is by far the most advanced IF in terms of ES progress, followed by World Athletics. Only 4 out of 32 have any sort of strategic ES plans. Only golf, surfing, football, sailing, and hockey have received any academic attention. There is a significant lack of understanding of environmental practices across sport, and their drivers/barriers. There is limited accountability with regards to ES progress and activities throughout the Olympic Movement. This has resulted in uneven diffusion of environmental activities.

Originality: This paper is a new contribution to sport management and ES literature. It provides a benchmark of understanding for ES in the Summer Olympic Programme for the first time using a hierarchy of information to ground results. The exploration and comparison of the perspectives of separate sports adds to the paper's originality.

Keywords

Environmental Sustainability, Sport Management, International Federations, Olympic Games, Olympic Movement

Open Peer Review

Approval Status ?

1

version 1

07 Jul 2021

1. **Cheryl Mallen**, Brock University, St. Catharines, Canada

Any reports and responses or comments on the article can be found at the end of the article.



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Author roles: **Santini D:** Conceptualization, Data Curation, Formal Analysis, Investigation, Methodology, Project Administration, Resources, Visualization, Writing – Original Draft Preparation; **Henderson H:** Conceptualization, Funding Acquisition, Project Administration, Supervision, Visualization, Writing – Review & Editing

Competing interests: No competing interests were disclosed.

Grant information: The authors disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: this work was supported by the University of Exeter.

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How to cite this article: Santini D and Henderson H. **The winners and losers in the race to environmental sustainability: a ranking of Summer Olympic International Federation progress [version 1; peer review: 1 approved with reservations]** Emerald Open Research 2021, 3:12 <https://doi.org/10.35241/emeraldopenres.14195.1>

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Introduction

Background

Climate change has and will have a plethora of negative effects on all global anthropogenic systems, posing a variety of risks for the sport sector (Edenhofer *et al.*, 2015). Immediate climate change mitigation amongst sport organizations is therefore vital (Orr & Inoue, 2019). Environmental sustainability in sport management is a relatively nascent discipline (Mallen *et al.*, 2010; McCullough *et al.*, 2020a). All aspects of all sports exert an impact on the natural environment, however due to the bidirectional relationship that exists, it is in the best interest of the sporting sector to preserve the natural environment (Brymer *et al.*, 2009; Brymer & Gray, 2010; McCullough *et al.*, 2016). This is especially true for those sports whose very existence depends on the ability to directly interact with the natural environment, such as watersports (Gilchrist & Wheaton, 2017; Humberstone, 2011; Krein, 2014). Consequently, in response to accelerating climate change, the Olympic Movement's (OM) engagement in environmental sustainability (ES) activities has increased over the past decade (McCullough *et al.*, 2020b).

Research in sport remains largely focused on multi-sport mega-events such as the Olympic Games (OG) (Mallen *et al.*, 2010). Whilst an attractive phenomenon to study, due to its unique size and nature, the OG do not constitute the majority of global sporting events (Forrest *et al.*, 2010). Despite the significance of their activities, International Federations in the OM are being overlooked. There are 32 Olympic-recognised International Federations (IFs) that represent 47 individual sports in the Summer Olympic programme (Table 1). The disproportionate academic attention that the OG receives relative to the rest of the OM, highlighted in Table 2, has narrowed the lens through which issues are viewed (Forrest *et al.*, 2010).

Context

In a review of environmentalism throughout the OM's history, Del Fiacco & Orr (2019) identified that ES came onto the International Olympic Committee's (IOC) radar and agenda in 2010. Consequently, 2010 has been selected as the lower boundary for the time period examined by this paper. Only in 2017 did the IOC announce a sustainability strategy that extends past

Table 1. The 32 International Federations and sub-sports recognised by the International Olympic Committee for the 2020 Summer Olympic Programme (Sources: ASOIF; Tokyo 2020 Organizing Committee).

Sport	International Federation (IF)	Sub-Category Sports
Archery	World Archery	
Athletics	World Athletics	
Badminton	Badminton World Federation	
Baseball	World Baseball Softball Confederation	
Basketball	International Basketball Federation	
Canoeing	International Canoe Federation	Canoe Slalom Canoe Sprint
Cycling	International Cycling Union	Cycling BMX Cycling Mountain Bike Cycling Road Cycling Track
Equestrian	International Equestrian Federation	Equestrian Dressage Equestrian Eventing Equestrian Jumping
Fencing	International Fencing Federation	
Football	International Association Football Federation	
Golf	International Golf Federation	
Gymnastics	International Gymnastics Federation	Gymnastics Artistic Gymnastics Rhythmic Trampoline
Handball	International Handball Federation	
Hockey	International Hockey Federation	
Judo	International Judo Federation	

Sport	International Federation (IF)	Sub-Category Sports
Karate	World Karate Federation	
Modern pentathlon	International Modern Pentathlon Union	
Rowing	World Rowing	
Rugby sevens	World Rugby	
Sailing	World Sailing	
Shooting	International Shooting Sport Federation	
Skateboarding	World Skate	
Sport climbing	The International Federation of Sport Climbing	
Surfing	International Surfing Association	
Swimming	International Swimming Federation	Artistic Swimming Diving, Marathon Swimming Swimming Water Polo
Table tennis	International Table Tennis Federation	
Taekwondo	World Taekwondo	
Tennis	International Tennis Federation	
Triathlon	International Triathlon Union	
Volleyball	International Volleyball Federation	
Weightlifting	International Weightlifting Federation	
Wrestling	United World Wrestling	Wrestling Freestyle Wrestling Greco-Roman

Table 2. International Olympic Committee and International Federation events compared to academic attention received.

	International Olympic Committee	International Gymnastics Federation	International Fencing Federation	World Archery Federation
Number of events held in 2016 (Olympic and non-Olympic sanctioned)	1	22	154	27
Search term used	Olympic Games	Olympic Gymnastics	Olympic Fencing	Olympic Archery
Literature search results between 2015 – 2017	23,000	7,420	3,460	2,110
Ratio of literature search results per event	1 : 23,000	1 : 337	1 : 22	1 : 78

host bidding to include the whole OM (Del Fiaccio & Orr, 2019). Now more than ever, IFs must engage in ES activities.

The scale of transformation required to effectively implement ES across IFs demands strategic planning (Dolf & Teehan, 2015; McCullough *et al.*, 2016). The current state of this is yet to be explored academically. Due to commercialization, many sport

and business management sub-disciplines are converging, such as organisational change theories (Maier *et al.*, 2016). This can provide insight into the barriers, drivers, and diffusion of ES practices across the OM. Whilst the IOC holds ultimate authority regarding the OM's overall strategy, tactical power and governance is de-centralised (Dolles *et al.*, 2011). This governance structure affects the pace and commitment at which strategy is

implemented (Geeraert *et al.*, 2014). Studies have shown that due to the high levels of autonomy that IFs have been granted and the lack of internal accountability, strategic objectives become watered down at increasingly local levels, resulting in inconsistent outcomes (Graham *et al.*, 2018; Smith, 2010). The structure of OM governance suggests that isomorphic change may not be as simple as a uniform, top down process (Forster, 2006; Geeraert *et al.*, 2014; Smith, 2010). Subsequently, the isomorphic change required for all IFs to transition towards ES may be driven by multiple factors.

Isomorphic change occurs when organisations with similar operational functions and purpose (such as IFs) adopt similar behaviours to survive external changes (Babiak & Wolfe, 2009; Cunningham & Ashley, 2001). Three main perspectives on the drivers of isomorphic change exist. Institutional theory presents external governance as the main determinant of organisational change, whereas population ecologists stipulate that it arises primarily from resource-scarcity (Abson *et al.*, 2017; Washington & Patterson, 2011). Both argue that change is undergone reactively. The third perspective is strategic choice, which attributes organisational change to proactive internal decision-making rather than external factors (Cunningham & Ashley, 2001).

The OM's environmental management strategy has been reactive thus far, suggesting the presence of institutional and resource-related pressures (Del Fiacco & Orr, 2019; Paquette *et al.*, 2011). However, another study asserted that institutional theory and strategic choice were key to understanding IF behaviour (Phelps & Kent, 2010). Thus, all three drivers are potentially present across the OM, however the extent to which they influence ES progress remains undetermined.

Without internal accountability measures, it is difficult to identify the extent to which IFs are engaging in ES practices (Geeraert *et al.*, 2014; Sartore-Baldwin & McCullough, 2018). Where there is an absence of formal records other documentation, such as external online communications, can provide insight into organisational activities (Pedersen, 2013). According to the Strategic Sport Communication Model (Pedersen, 2013), external strategic communication in sport involves multiple platforms, such as websites and social media. Websites are a relatively formal online channel, and have become vital tools for reporting CSR activities, such as ES progress (Ciletti *et al.*, 2010; Kim & Kuljis, 2010). Social media in sport is also used to provide activity updates however, in a significantly more accessible and public-facing way (Filo *et al.*, 2015; Pedersen, 2013). Multi-directional relationships between macro factors and the content of these digital platforms exist, and agenda setting theory argues that topics receiving high levels of media coverage determine the public agenda in wider society (Rowe, 2014). In sport, the few studies that have explored this theory have done so within the OG context and concluded that agenda setting is not present (Frederick *et al.*, 2015). However, other disciplines have shown that it is present for ES (Bache, 2013; Pollach, 2014). There is limited understanding of agenda setting and ES within the context of the OM. This is exacerbated by researchers analysing only one digital

platform, and the fact that IFs have yet to be the subject of ES communication studies (Frederick *et al.*, 2015; Pedersen, 2013; Pegoraro, 2014).

This paper aims to create a benchmark ES progress ranking across the 32 IFs in the Summer Olympic Programme. The purpose of this research is to collect and evaluate available knowledge in order to inform strategic ES decision-making within the OM.

Literature review

Review process. Evaluating the extent to which each IF is making ES progress requires identification of the barriers, drivers, and ES practices that exist in single-sport contexts. To review large quantities of information and extract the most significant findings, a systematic literature review method was used (Mulrow, 1994). Searches were conducted across six of the highest quality electronic research databases: Google Scholar, Scopus, EBSCOhost, ScienceDirect, ResearchGate, Emerald Insight and ProQuest (Xiao & Watson, 2019). Key terms (and any variation) were required to be present in the article's title, abstract or keywords. For example: ('athletics' AND ['environmental sustainability' OR 'environment' OR 'sustainability']). This search process resulted in an initial population of 50 articles (Figure 1).

Sport specific literature. Golf course operators are moving towards ES at different rates mainly due to a lack of financial resources (Huth, 2017; Keogh *et al.*, 2014; Minoli, 2018). Whilst strategic planning could strengthen the argument for financial support, ES activities are ad hoc, as their process of initiation is often unclear to staff (Keogh *et al.*, 2014; Minoli, 2018). Huth (2017); Minoli (2018), and Scott *et al.* (2018) found (respectively) that the presence of certification, legislation and regulatory pressure induced ES progress. All interventions explored involved economic incentives. Certification is effective when the long-term economic benefits of achieving it are clearly communicated (Huth, 2017). The examination of the Ontario Ministry of Environment's water conservation programme by Scott *et al.* (2018) revealed the strong potential of regulatory pressure. The intervention mandates that organisations pay for permits to extract more than 50,000 litres of fresh water per day whilst collecting data and increasing water conservation efforts amongst businesses which are aiming to reduce costs. Efficient and off-the-grid irrigation systems were widely used by golf courses to reduce dependence on fresh water sources. Water needs vary according to soil type, manageable through the use of soil moisture sensors and wetting agents (Pacini *et al.*, 2016). However, lack of awareness surrounding the impact of soil management means that the uptake of these methods remains low (Scott *et al.*, 2018).

ES progress in surfing is mainly attributed to reporting, partnerships, and governance. Martin & Assenov (2014a) provided a starting point for ES data collection by creating the Surf Resource Sustainability Index (SRSI), however it is unclear the extent to which this has been applied in practice. Martin & Assenov (2014b) empirically substantiated the affinity to the

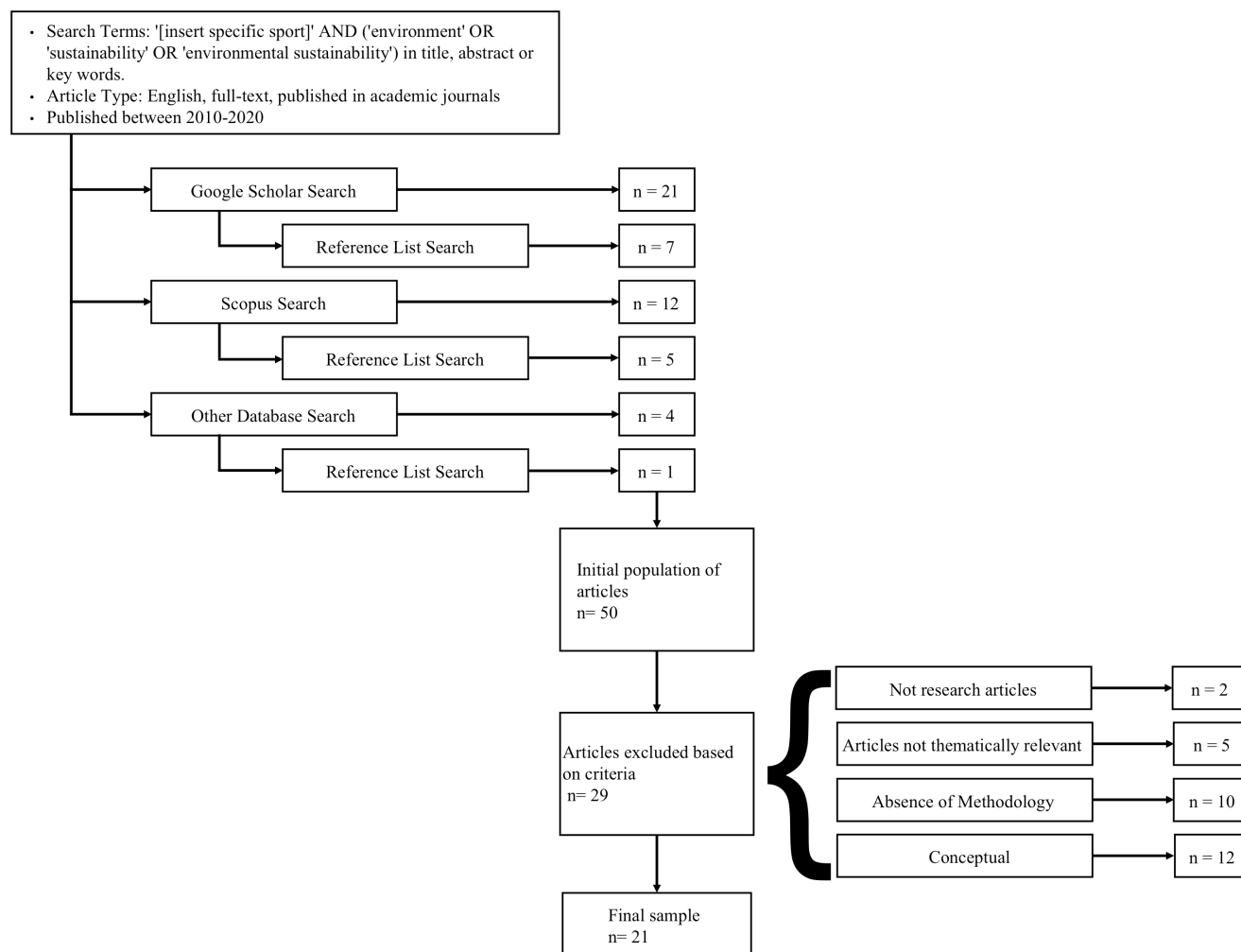


Figure 1. Flowchart breakdown of the systematic literature review process.

natural environment that surfers have, and this has contributed to the sport's ES progress through the creation of charities. [Ratten's \(2019\)](#) study was the only one to explore an IF-related intervention. The World Surfing Reserves (WSR) were created in association with the International Surfing Association (ISA) as a social innovation programme that identifies specific coastal areas to preserve for surfing. Funding for conservation is gained by attracting sporting activities to the area. The enforcement of these ES interventions effectively increases the uptake of ES practices in surrounding local areas.

No barriers to ES progress were uncovered in football literature, which [Francis *et al.* \(2017\)](#) attributes to the sport's popularity providing relatively unrestricted access to resources. Partnerships were found to have positive effects on inducing strategic ES planning ([Baldwin, 2010](#)). ES progress was only explored at club level, and the general rate of activities beyond recycling varied, as almost all ES activities were ad hoc ([Baldwin, 2010](#); [Francis *et al.*, 2017](#)). The only paper to provide an international perspective was [Pereira *et al.*'s \(2017\)](#) innovative work, which applied mathematical modeling to

determine the optimal location for the FIFA (Federation Internationale de Football Association) World Cup from an environmental perspective. The paper concludes that host country selection should occur after the team qualification round to significantly reduce environmental impacts. Although its implications are invaluable, it is unclear whether FIFA are aware of this model.

Only one ES article was found each for sailing and hockey. Both pertained to sport-specific equipment material innovation, and proved the viability of alternative bio-composite materials. [Al Rashid *et al.* \(2020\)](#) concluded that hybrid polymer matrix composites reinforced by banana fibers are structurally stronger than glass fiber reinforced by epoxy resin, whilst [Castegnaro *et al.* \(2017\)](#) proved that bio-composite materials were a successful alternative to fibreglass.

Methods

Multi-criteria analysis methods enable complex topics such as ES to be deconstructed by applying hierarchical criteria to assess alternatives ([Ahmad & Tahar, 2014](#)). Based on data

extracted from websites, an analytical hierarchy of information was created to arrange IFs in order of ES progress. Social media can provide the insight necessary to triangulate these findings, and distinguish between IF progress within each ES tier (Baruah, 2012; Pedersen, 2013; Pedersen, 2014). Twitter was selected as all IFs use it to engage with the public about their activities, and its hashtag system creates easy-to-navigate digital archives about topics (Filo *et al.*, 2015; Frederick *et al.*, 2015).

Hierarchy of information

To identify and code information in a consistent manner, an iterative approach was applied to a multistep content analysis (McCullough *et al.*, 2020b). IF websites were systematically searched for content using the search terms: “sustainable”, “sustainability” and “environment”. Sequential criteria were developed based on adapting and combining environmental communication theories and content analysis principles (Figure 2) (Boykoff & Mascarenhas, 2016; Delmas & Burbano, 2011; Hu *et al.*, 2011; Jin & High, 2004; Jose & Lee, 2007). A binary coding system was applied to record the presence of criteria. The dates that each IF met criteria were recorded to create time-stamped progress points. Considering the multi-year period examined, monthly timestamps enabled optimum clarity (Neuendorf, 2016). Logic was combined with content analysis principles to define each criterion’s timestamp (Figure 2).

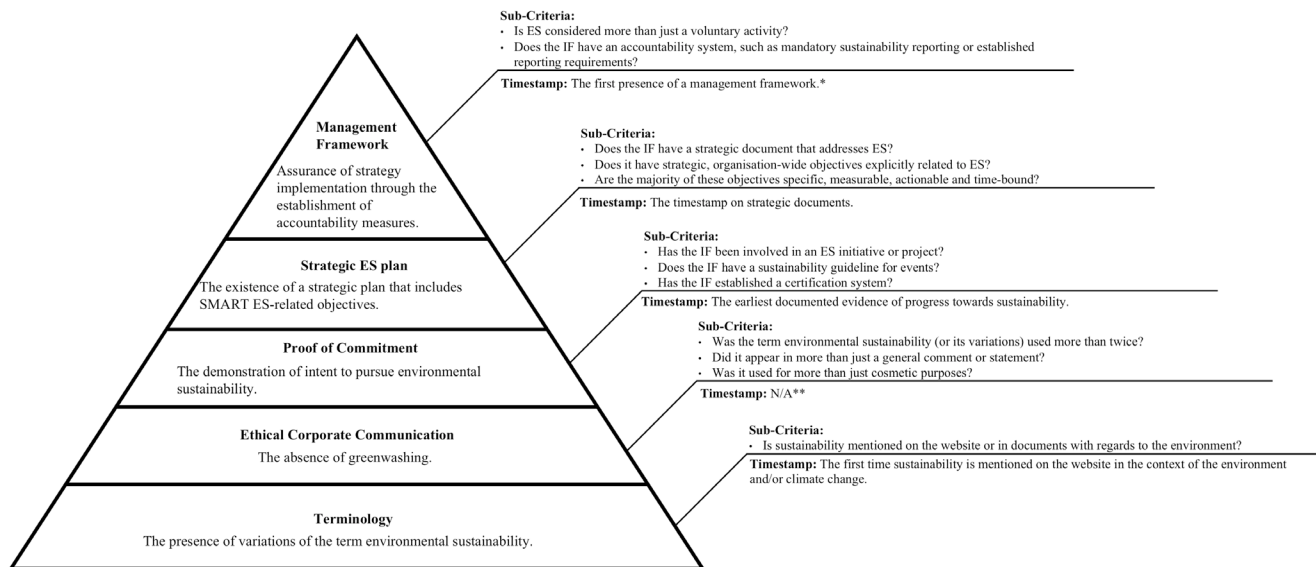
Social media

Official IF Twitter accounts were searched for the terms “sustainability” OR “sustainable” OR “environment”, either as a hashtag or in post content. Data collection occurred 14th-24th August 2020, consequently the most recent data for the year

2020 ends on this date. Due to the platform’s character limit, multiple tweets on the same day about the same topic were regarded as one single post. Posts were only included if the key terms related to ES, which was determined by human coding. In order to ensure content was factually accurate, embedded links were assessed. Only posts with functioning links, containing ES-related content were included.

Exploring the drivers of ES progress and re-evaluating the Hierarchy of Progress (HoP) requires ES progress data and social media content to quantitatively and proportionally represent each progress points’ importance. The criteria used for the HoP, increased sequentially in terms of complexity, impact, and resource requirements (Neuendorf, 2016). Not all criteria nor the steps between them are equal and communication of different progress types reflects varying levels of effort. Weighting factors were therefore assigned to HoP criteria and tweet content types. Four main types of ES tweet content were identified through an iterative process of analysing communication purpose then the content itself (Table 3). The range of themes was too wide to generate meaningful findings from thematic analysis methods so content analysis was conducted on a case-by-case basis (Neuendorf, 2016).

As it was difficult to quantify and compare all elements contributing to the achievement of ES progress, working norms for weighting factor calculation were developed which were grounded in logical mathematic progression principles (Neuendorf, 2016). This determined that the first criterion in the series was given a weighting factor of 1. The progression used an interval (*i*) of +1 ($i = n+1$) meaning that each interval in the series increased by one (i.e. +2, +3, +4, +5). This process was implemented for both HoP criteria (Table 3) and content type (Table 4).



* All Management Frameworks were located within the Strategic ES Plan as such, the dates for these criteria were the same.

** As sub-criteria inherently required there to be multiple data points, selecting a single or average timestamp to represent these could lead to inaccuracies in the dataset, and disrupt any patterns (Neuendorf & Kumar, 2015; McCullough, Pelcher & Trendafilova, 2020). Consequently, timestamps for Ethical Corporate Communication were excluded to ensure accuracy, reliability, and validity of findings.

Figure 2. Final analytical hierarchy of information criteria, sub-criteria and timestamps.

Table 3. Hierarchy of information criteria weighting factors.

Criteria	Weighting Factor
Terminology	1
Ethical corporate communication	[3]*
Proof of commitment	6
Strategic environmental sustainability plan	10
Management framework	15

*The sole purpose of assigning a weighting factor to these criteria is to demonstrate the weighting pattern. The multiple data points required for these criteria would result in a skewed data set if weightings were applied. It is not utilised past this point.

Table 4. Tweet content types, descriptions, and weighting factors.

Tweet Content Type	Description	Weighting Factor
Awareness	Content aimed at increasing awareness and engagement with an environmental sustainability (ES) topic or issue or sharing general ES information	1
Progress	Communication about ES progress projects and initiatives	3
Reporting	Includes showcasing internal progress reports or measurements, as well as engaging with stakeholders to feedback on ES activities	6
Milestone	Milestones or notable achievements	10

External factors

Consistent with Rowe (2014) preliminary inclusion criteria for all external factors required that they were major events that had an impact on all IFs. Selection was informed by the literature reviewed and based on this paper's foci: environmental sustainability, sport, and the intersection at which they meet. Drawing from Pedersen's (2013) Strategic Sport Communication Model, three categories of external factors were identified: sport-specific events (i.e. the OGs); sport-related ES interventions; and societal ES events.

Del Fiacco & Orr (2019) asserted that the OG have influenced ES throughout the rest of the OM. To determine the extent to which it is a driver of ES amongst IFs, Summer OG since 2010 (London 2012, Rio 2016, and Tokyo 2020) will be mapped against ES progress and tweets. Timestamps will be the month of the OG's end date, as IFs are occupied with other activities during the games. Observing trends post OG will allow for clearer analysis.

Sport policy, systems thinking, and sustainability transitions research indicated that scope of control and intended outcome were the most suitable criteria upon which to base intervention selection (Abson *et al.*, 2017; Kelly, 2011; Luederitz *et al.*, 2017; Sallis *et al.*, 1998). Therefore, interventions had to be global in reach and aimed to induce, accelerate, or sustain IF ES activities. Five interventions were subsequently identified (Figure 3).

Societal factors

Consistent with agenda setting theory, a relationship likely exists between macro-societal factors, public awareness of ES, and IF ES progress and/or tweets (Rowe, 2014). The event categories that have driven the increase in public awareness of climate change over the past five years are namely; the publication of major scientific reports (Hamilton, 2016), global climate summits, and their outcomes (Bakaki & Bernauer, 2017), the rise of key activists and advocacy groups (Carmichael & Brulle, 2017), and high profile environmental documentaries (Males & Van Aelst, 2020). Determining which category most influences IFs requires a narrower geographic scope. A large majority of IF HQs are located in Europe and likely impacted by events that received mass media attention in this region (Knight, 2016). To compare the effects of different categories, one event that entered the European mass media from 2010–2020 was selected from each. Five major events were selected in Figure 4.

Hypotheses

The presence of research across only five sports suggests that these sports will have made the most ES progress (Popay *et al.*, 1998). As watersports have a higher dependence on the natural environment than others, it is likely that their affinity to the environment will be reflected by their progress. OM awareness of ES has increased over the last decade, which is likely reflected by the number of IF ES communications (Del Fiacco & Orr, 2019). As one of social media's primary purposes is

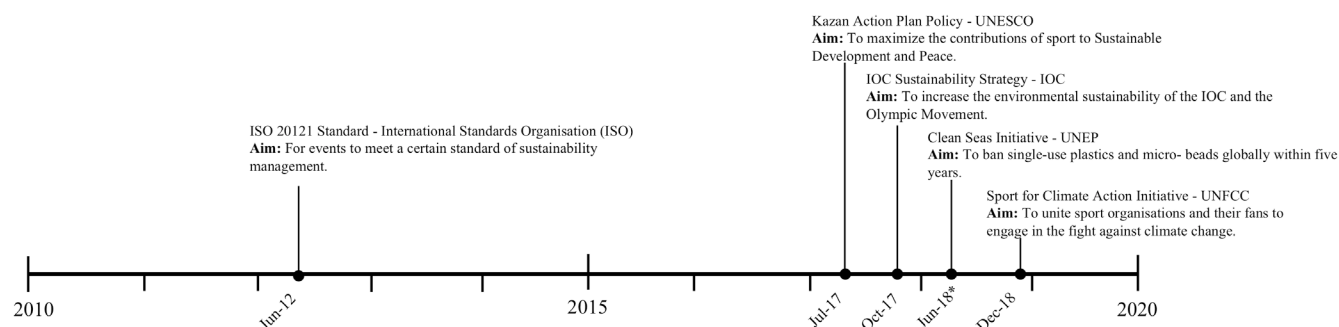


Figure 3. The selected interventions (Sources: IOC ; UNEP; UNESCO ; UNFCCC).

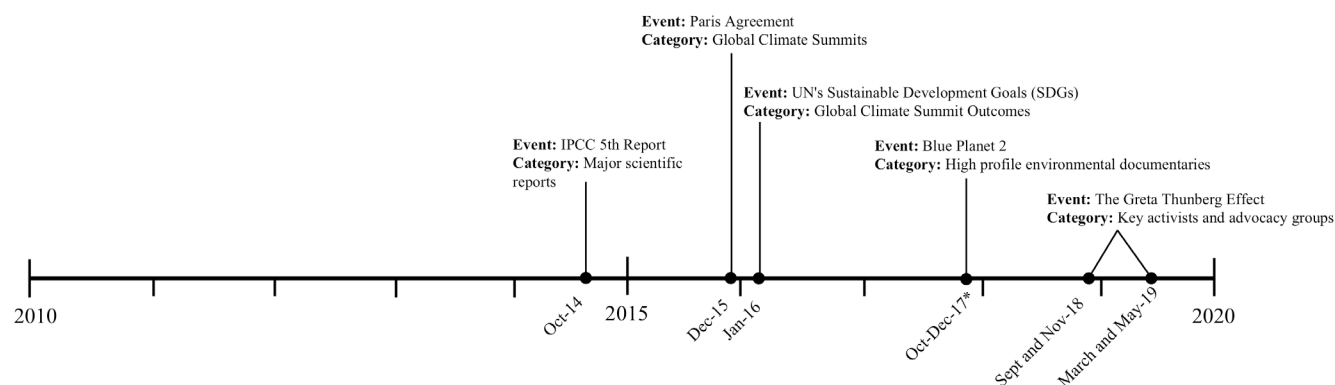


Figure 4. The selected societal environmental sustainability events.

to disseminate information about activities, logic dictates that ES tweets are likely the result of ES progress (Clavio & Walsh, 2014; Filo *et al.*, 2015). ES tweets made by IFs likely mirror the ES tiers. The literature review indicated that the strongest driver of progress was governance, and this trend should be observed across ES tweets and progress (Abson *et al.*, 2017). The following hypotheses have been formed (Figure 5).

Results

All 32 IF websites were analysed and ordered according to ES progress (Figure 6). The HoP revealed that only 15 IF websites featured the term “sustainability” in reference to the environment, one of which was cosmetic in nature. In total, 13 IFs demonstrated commitment by having statements of intent, guidelines for event organisers, by participating in an ES project or initiative, and/or having voluntary certification systems in place. Only four IFs had strategic ES plans with explicit SMART objectives, two of which had mandatory accountability measures. World Sailing and World Athletics, followed by World Rowing (WR) and FIFA, have made the most progress. Although WR’s strategy mentions voluntary certification as an aim, and FIFA reports on World Cup events, neither require subsidiaries to engage in ES activities.

IFs were grouped into tiers according to level of progress (Table 5), no pattern was observed regarding the percentage of IFs in each tier. This uneven distribution of progress suggests that ES is not diffused across the OM by organisational level. As their website content shows an absence of ES awareness, 53% of IFs are Tier 6. Consistent with literature, many ES efforts are ad hoc and lack strategic commitment, with 28% of IFs falling into Tier 3. Whilst the IFs for sailing and football were both classed in the top two tiers, surfing and golf were both in Tier 3, and hockey was a Tier 6 sport. Although these findings do not support hypothesis 2 (H2), hypothesis 1 (H1) holds true to an extent, as two of the top four are watersport IFs.

Social media findings

A total of 7 IFs did not contribute to the dataset as golf, handball, and tennis IFs ($n=3$) had 0 ES post results whilst badminton, gymnastics, shooting, and skate ($n=4$) were categorized as having 0 posts after analysis revealed that none were substantiated. The final sample included 188 ES tweets (Figure 7). Since 2010, IFs have posted a total of 718,295 tweets, meaning that only 0.03% of Twitter content published by IFs is related to ES. Figure 7 shows total ES posts per year from 2010–2020. The year with the most ES posts was 2020 ($n=56$) followed



Figure 5. Paper hypotheses (H1-6).

by 2019 ($n=39$). There was an increase in ES-related posts from 2010 to 2013, which subsequently fell in 2014 and 2015. This may be related to the OM's environmental phases, in which efforts were intense until 2012, however, does not explain the continued increase in 2013, and following decline in ES attention until 2015 (Del Fiacco & Orr, 2019). ES posts have experienced consistent annual growth since 2015, with the steepest increase in posts being from 2017 to 2018, suggesting significant ES progress during this time. Consistent with hypothesis 5 (H5), an overall increase of 55% from 2010 to 2020 was observed with a steady annual increase from 2015 onwards.

There is a relationship between ES tweets and weighted ES progress points (Figure 8). The peaks of progress are close to those of tweets but appear slightly offset. For example, progress made in September 2018 and April 2020, immediately precede spikes in ES tweets from October-November 2018 and May-July 2020, respectively. Typically, peaks in progress occur within the same month or immediately before an increase in ES tweets. Whilst the timing of the offset varies, there is a noticeably stronger relationship in second half of the decade than first, as increases in progress and tweets coincide more closely. For example there is a significant increase in progress in July 2015 however no increase in ES tweets around this time. Conversely wherever there is an increase in progress in the second half of the decade, there is an increase in ES tweets. The two variables approximately follow the same trend, suggesting that there may be external factors influencing both. Three categories of external factors were examined: OG, sport-related ES interventions, and public ES events.

External factors and ES

In the year following both the London 2012 and Rio 2016 OG, the overall number of ES tweets increased (Figure 9). Due to

the coronavirus disease 2019 (COVID-19) pandemic, the Tokyo 2020 OG was postponed and this trend could not be observed a third time. Despite this, there was a spike in ES tweets in the months prior to when the 2020 games should have been, suggesting communication of ES in anticipation of the games.

The large majority of post content does not reference the games; however the consistent timing of these increases suggests that the OG raise ES awareness amongst IFs. For instance, the successful London 2012 ES strategy that brought sustainability to the forefront of the OM likely impacted ES communications (Del Fiacco & Orr, 2019). Although a significant increase in progress can be observed following Rio 2016, this was a result of activities completely unrelated to the OM. Therefore, as seen from the timing of surges in ES tweets, the OG do raise awareness of ES, but do not appear to directly cause progress.

Governance interventions were mapped in Figure 10. No correlation was found between ES interventions and the number of ES tweets posted or ES progress for points B (Kazan Action Plan), D (Clean Seas) and E (Sport for Climate Action). At points A (ISO20121) and C (IOC Sustainability Strategy), where spikes in ES progress coincide within one month of interventions, re-evaluation of IF website content was conducted. This revealed that progress was unrelated to interventions, which may be due to latency of implementation or uneven rate of intervention-induced practices. Whilst there is an increase in both the number of ES interventions introduced and ES activity in the second half of the decade, peaks in activity do not directly correspond to interventions. There is no apparent causal relationship between ES interventions and ES activity. Rather, it is likely that both the increase in ES interventions and activity is a result of the overall increase in ES awareness from 2016–2020.

IF	Terminology	Ethical Corporate Communication	Proof of Commitment	ES Strategy	Management Framework
World Athletics	✓	✓	✓	✓	✓
World Sailing	✓	✓	✓	✓	✓
World Rowing	✓	✓	✓	✓	×
International Association Football Federation (FIFA)	✓	✓	✓	✓	×
International Canoe Federation	✓	✓	✓	×	×
International Equestrian Federation	✓	✓	✓	×	×
The International Federation of Sport Climbing	✓	✓	✓	×	×
International Surfing Association	✓	✓	✓	×	×
International Triathlon Union	✓	✓	✓	×	×
United World Wrestling	✓	✓	✓	×	×
International Golf Federation	✓	✓	✓	×	×
World Rugby	✓	✓	✓	×	×
World Taekwondo	✓	✓	✓	×	×
Union Cycliste Internationale	✓	✓	×	×	×
International Modern Pentathlon Union	✓	×	×	×	×
International Volleyball Federation	×	×	×	×	×
World Archery	×	×	×	×	×
Badminton World Federation	×	×	×	×	×
World Baseball Softball Confederation	×	×	×	×	×
International Basketball Federation	×	×	×	×	×
International Fencing Federation	×	×	×	×	×
International Gymnastics Federation	×	×	×	×	×
International Handball Federation	×	×	×	×	×
International Hockey Federation	×	×	×	×	×
International Judo Federation	×	×	×	×	×
World Karate Federation	×	×	×	×	×
International Shooting Sport Federation	×	×	×	×	×
World Skate	×	×	×	×	×
International Swimming Federation	×	×	×	×	×
International Table Tennis Federation	×	×	×	×	×
International Tennis Federation	×	×	×	×	×
International Weightlifting Federation	×	×	×	×	×

Figure 6. The hierarchy of International Federation (IF) environmental sustainability progress (HoP).

Societal ES events

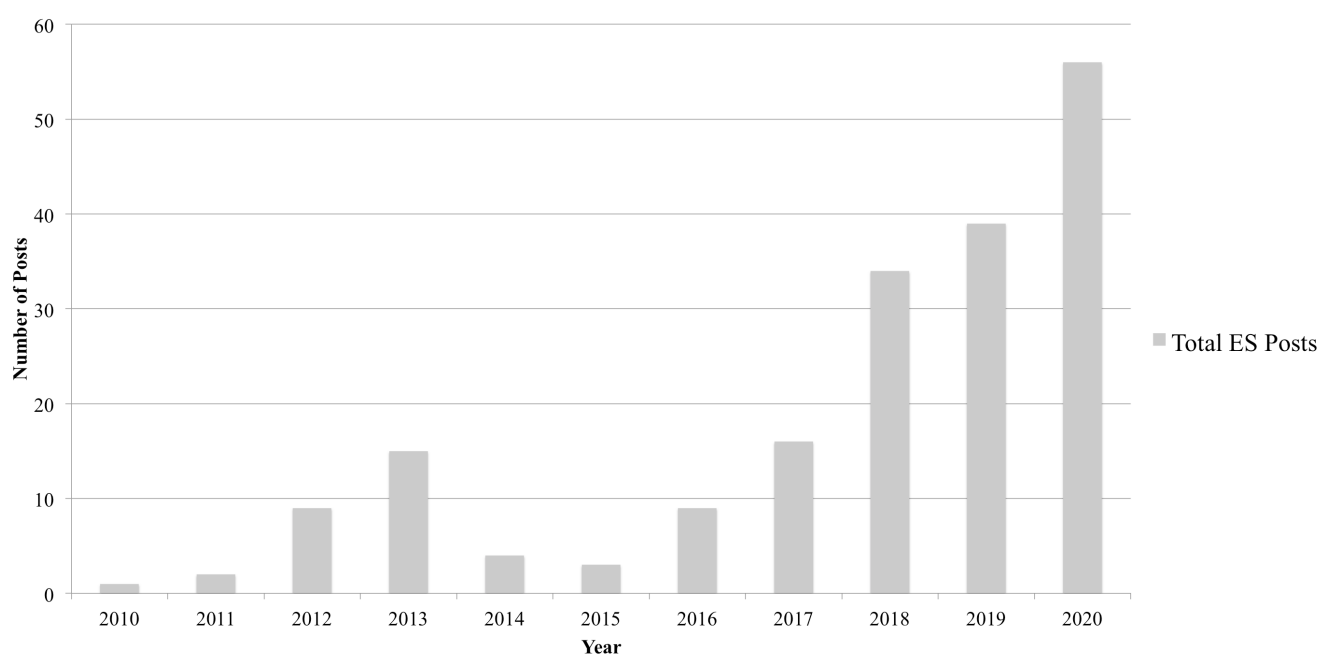
Selected societal ES events were plotted against ES tweets and progress (Figure 11). There does not appear to be a significant relationship between ES tweets and progress and the selected societal ES events when considered as a whole. However, closer analysis reveals that some events have a stronger impact than others. Points A (IPCC 5th report), B (Paris Agreement), and C (UN SDGs), could be considered official, political, and top-down strategic ES events (formal) whereas D (Blue Planet 2) and

E (Greta Thunberg) are more accessible, non-political and public-driven events (informal).

There was only one tweet relating to A, B or C, which was posted years after the event occurrence and no related progress was documented. Formal events appear to have little to no bearing on ES activities. The data might suggest that formal events had less impact on ES activities because they occurred before the mid-decade acceleration in global ES awareness.

Table 5. International Federation (IF) environmental sustainability progress tiers.

Tier	IF		%
1	World Athletics	World Sailing	7%
2	World Rowing	Federation Internationale de Football Association (FIFA)	7%
3	International Canoe Federation	United World Wrestling	
	International Equestrian Federation	International Golf Federation	
	The International Federation of Sport Climbing	World Rugby	28%
	International Surfing Association	World Taekwondo	
	International Triathlon Union	-	
4	Union Cycliste Internationale	-	3%
5	International Modern Pentathlon Union	-	3%
6	International Volleyball Federation	International Judo Federation	
	World Archery	World Karate Federation	
	Badminton World Federation	International Shooting Sport Federation	
	World Baseball Softball Confederation	World Skate	
	International Basketball Federation	International Swimming Federation	53%
	International Fencing Federation	International Table Tennis Federation	
	International Gymnastics Federation	International Tennis Federation	
	International Handball Federation	International Weightlifting Federation	
	International Hockey Federation	-	

**Figure 7. Total number of environmental sustainability (ES) tweets posted by all International Federations between 2010–2020.**

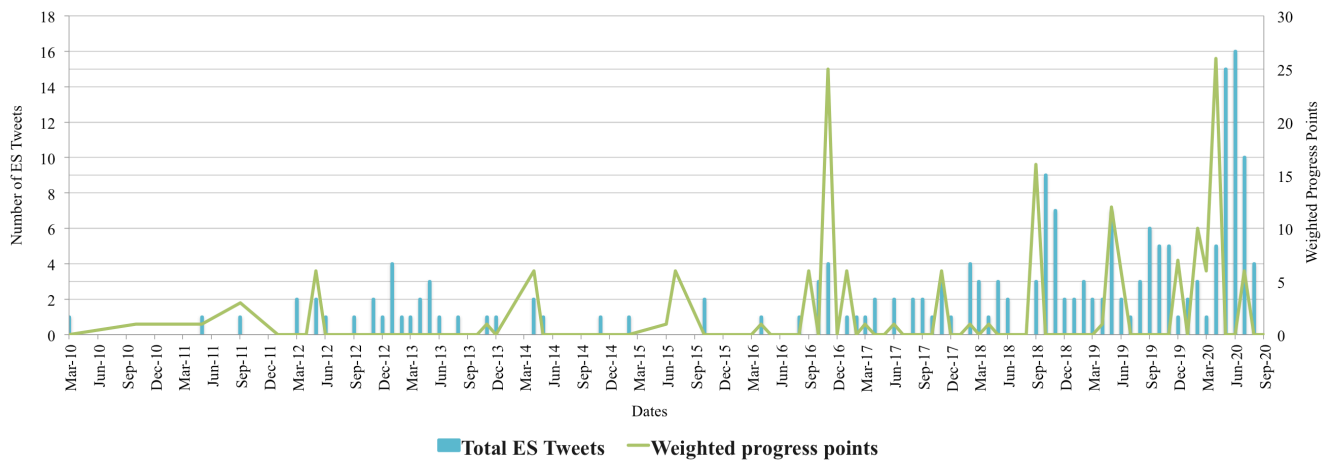


Figure 8. International Federation (IF) environmental sustainability (ES) progress vs. ES tweets 2010–2020.

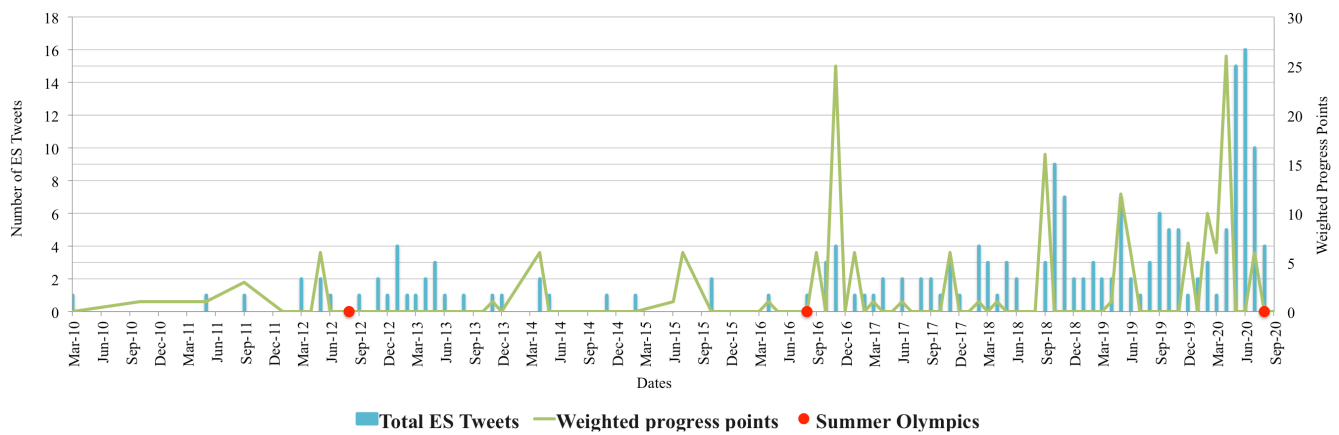


Figure 9. International Federation (IF) environmental sustainability (ES) progress and ES tweets vs. Olympic Games.

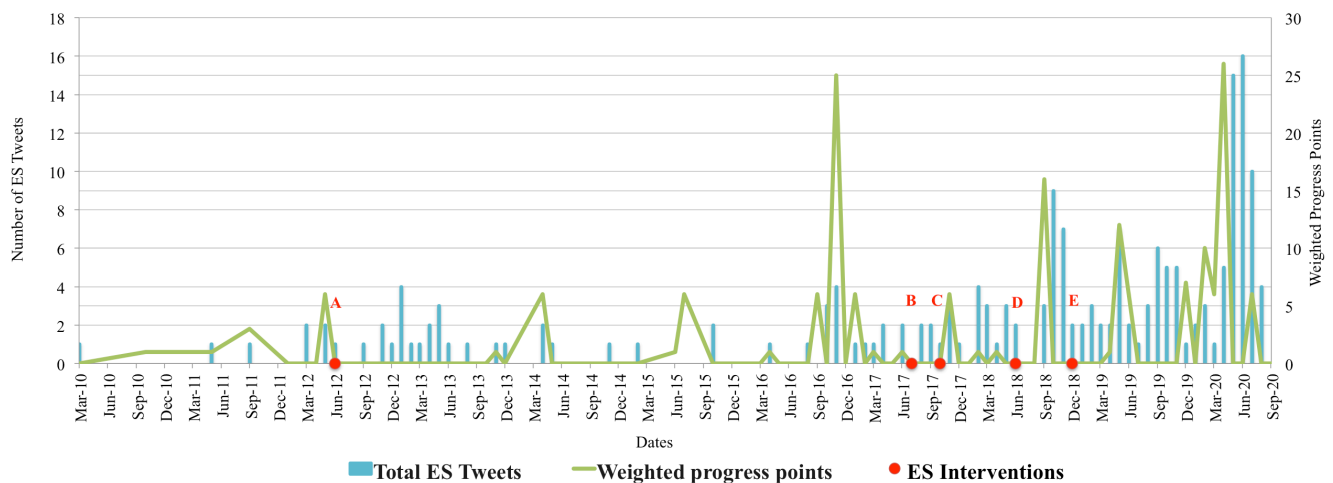


Figure 10. International Federation (IF) environmental sustainability (ES) progress and ES tweets vs. ES interventions.

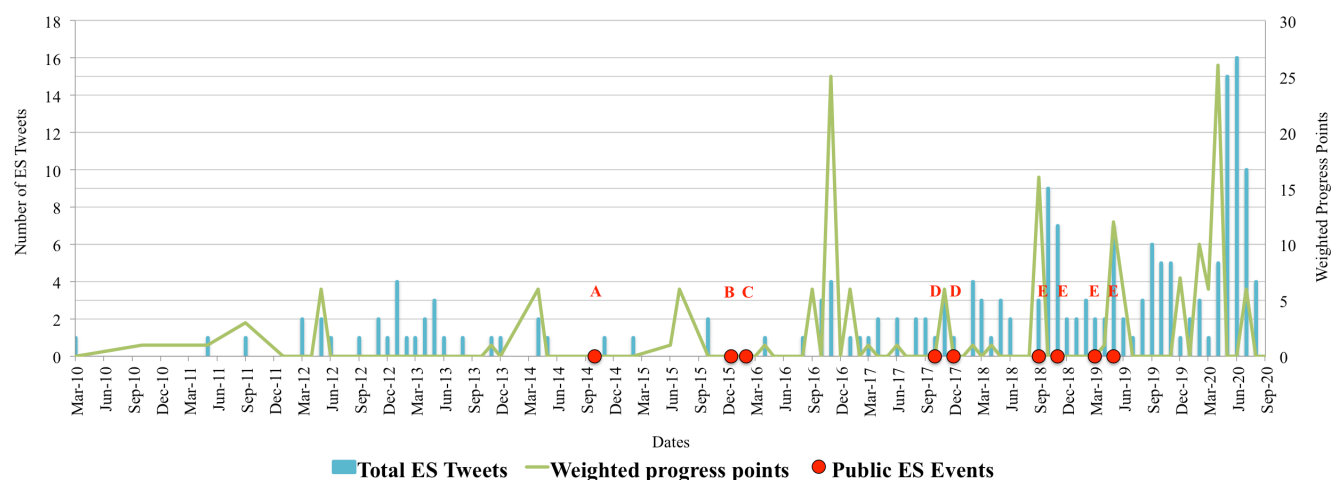


Figure 11. International Federation (IF) environmental sustainability (ES) progress and ES tweets vs. societal ES events.

However, other external factors (such as OGs) *have* had an impact in the first half of the decade, indicating that this is not a sufficient justification for lack of influence.

Informal events directly correspond to peaks in ES activity, suggesting the presence of agenda setting. Blue Planet 2 aired from October to December 2017 and raised global awareness of ocean plastics and pollution (Males & Van Aelst, 2020). Awareness increase is reflected by a spike in progress in November 2017, as well as an increase in plastic pollution-related content the following year. Throughout 2018, World Sailing and the International Surf Association were the most active IFs in this regard. The global rise in activism related to Greta Thunberg from September 2018 onwards had an effect on activities, with key events corresponding to advances in progress in September 2018 and May 2019. Although posts around this time do not refer directly to her ‘Fridays for Future’ protests, there has been an increase in content related to environmental stewardship and activism. For example, since November 2018, World Athletics have actively promoted the involvement of famous athletes in environmental projects.

ES communications per IF

The number of ES posts varied according to IF. It was hypothesized that the number of ES tweets would be directly proportional to the IFs ES progress tier. This was not found to be the case and Figure 12 shows the distribution of total ES posts per IF from 2010–2020. The four federations that posted the most about ES were World Sailing ($n=45$), WR ($n=29$), World Athletics ($n=17$), and International Surfing Association ($n=14$). FIFA, a Tier 2 federation, only posted 9 times about ES in the past decade, the same amount as the International Modern Pentathlon Union and World Rugby, both of which are Tier 5 federations. All Tier 1 and 2 IFs are in the top 5 posters of ES Tweets, and the ISA was the Tier 3 IF with the most ES tweets. Within Tier 3, United World Wrestling posted the least ($n=1$), being ranked the same, or lower, than most Tier 6

federations. The majority of Tier 6 IFs did not post about ES at all ($n=7$) or posted once ($n=5$). The International Fencing Federation posted the most ($n=6$) out of Tier 6 federations, ranking in the top ten and higher than the majority of T3 federations.

The purpose of the majority of ES posts was to generate awareness of ES issues (61%). ES progress (29%) was tweeted about the second most frequently, whilst IFs tweeted about Milestones and Reporting, 6% and 4%, respectively. Even if ES progress and subsequent communication increased, relative proportions between all types of content would likely remain similar due to the content’s inherent nature. This analysis enabled the HoP to be re-evaluated and refined. Figure 13 was plotted by applying weighting factors to content type, and the order of IFs within each progress tier was re-arranged (Table 6). All IFs in Tier 1 and 2 had content referring to milestones, whereas only half posted about Reporting. This compares to Tier 3, where no IFs engaged in reporting, and only the top four IFs tweeted about milestones. No IFs in Tier 4, 5 or 6 tweeted about milestones or reporting. In the following analysis, the term ‘ES advances’ will be used to describe the combination of milestones, reporting, and progress content types.

When tweet content is weighted, the progress differences between World Sailing and World Athletics are accentuated, with the former making significantly more advances. Although FIFA posted about reporting, WR did not, and both IFs had the same number of milestone posts ($n=1$). Overall WR made more advances than FIFA. There were no tiebreaks in Tier 3, and the International Surfing Association made the most ES advances. The International Fencing Federation and International Volleyball Federation were the most advanced Tier 6 IFs. The seven Tier 6 IFs with 0 ES posts, were all grouped together as having made no advances.

There were two instances of tie-breaks in Tier 6. The first was between the International Judo Federation (IJF), the

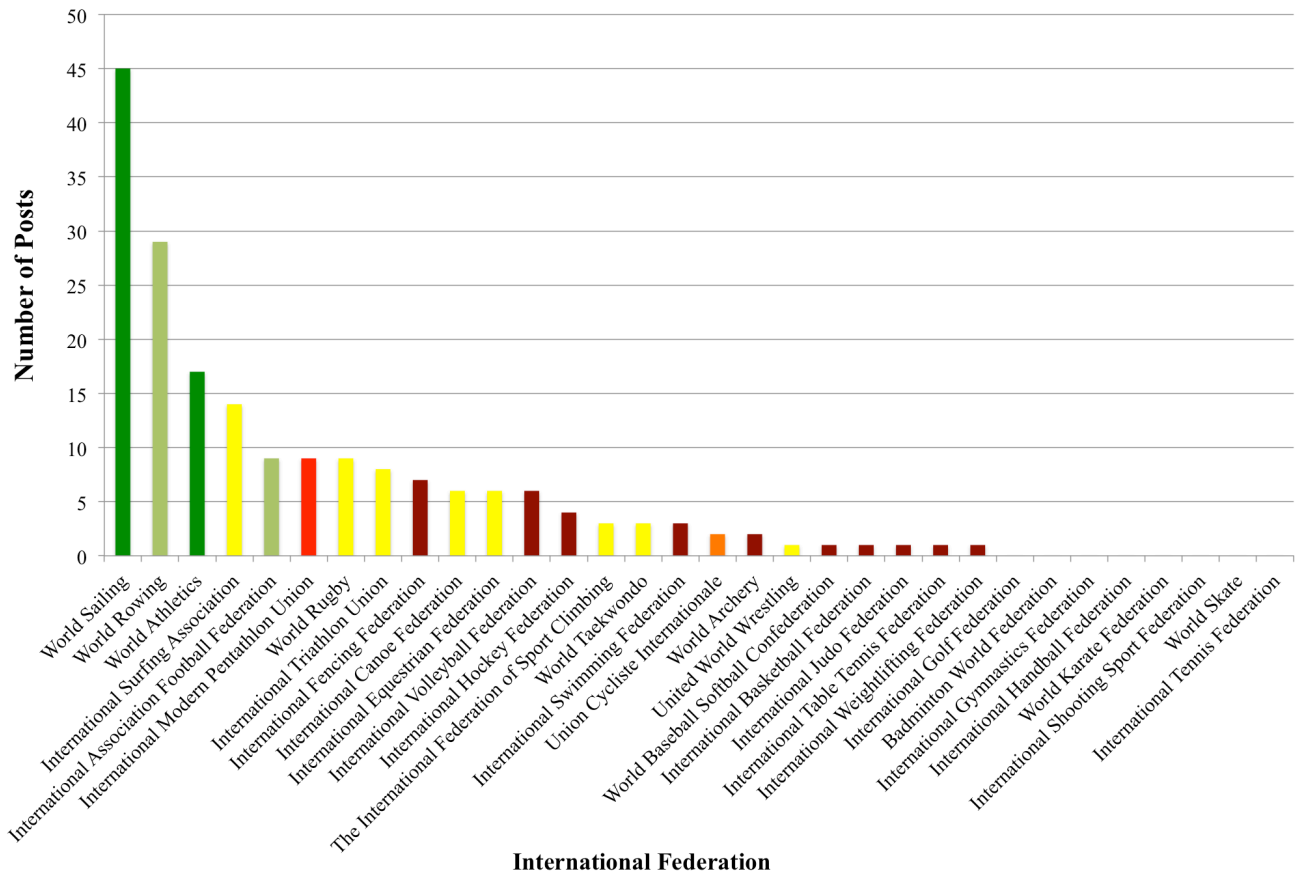


Figure 12. Number of environmental sustainability tweets posted by each International Federation between 2010–2020.

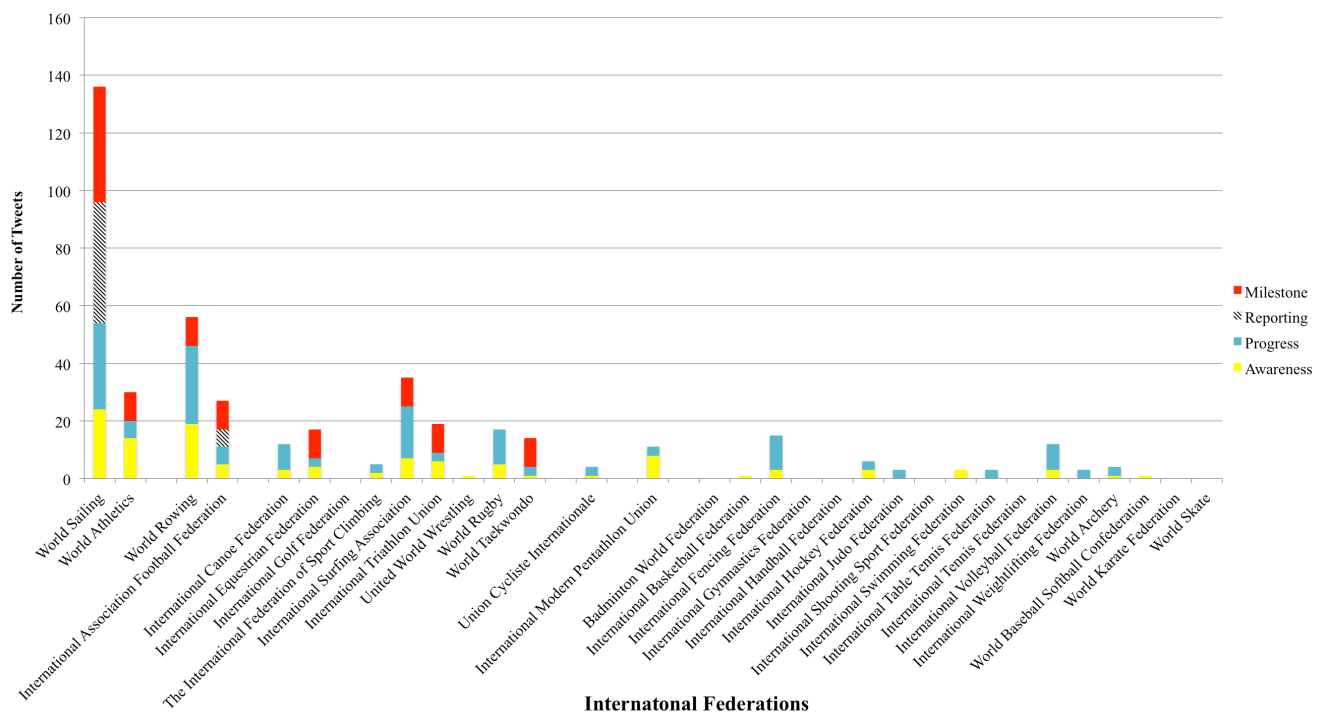


Figure 13. Environmental sustainability tweets posted by International Federations according to content type (weighted).

Table 6. Re-ranked International Federation (IF) environmental sustainability progress tiers.

Tier	Rank within tier	IF
Tier 1	1	World Sailing
	2	World Athletics
Tier 2	1	World Rowing
	2	Federation Internationale de Football Association (FIFA)
Tier 3	1	International Surfing Association
	2	International Triathlon Union
	3	International Equestrian Federation
	4	World Rugby
	5	World Taekwondo
	6	International Canoe Federation
	7	The International Federation of Sport Climbing
	8	United World Wrestling
	9	International Golf Federation
Tier 4	1	Union Cycliste Internationale
Tier 5	1	International Modern Pentathlon Union
Tier 6	1	International Fencing Federation
	2	International Volleyball Federation
	3	International Hockey Federation
	4	World Archery
	5	International Table Tennis Federation
	6	International Weightlifting Federation
	7	International Judo Federation
	8	World Baseball Softball Confederation
	9	International Basketball Federation
	10	International Swimming Federation
	11	Badminton World Federation
		International Gymnastics Federation
		International Handball Federation
		International Shooting Sport Federation
		International Tennis Federation
		World Karate Federation
		World Skate

International Table Tennis Federation (ITTF), and the International Weightlifting Federation (IWF) which each posted one progress tweet. Primarily, the IJF announced that the theme

for World Judo Day 2019 was 'Plant a Tree', however, there was no information regarding projects that were implemented so impact could not be verified. This compares to IWF who

posted about an initiative to plant a tree for every medalist at an international event. ITTF created an educational course about environmental equipment production. Unlike IWF's event-specific initiative, which occurred in isolation, ITTF engaged in an activity that was organisation-wide. ITTF was deemed to have made more ES progress than IWF, both making more advances than IJF. The second tie-break was between World Baseball Softball Confederation (WSBC) and the International Basketball Federation (FIBA). WSBC's tweet related to the green design of a Tokyo 2020 stadium whereas FIBA's posted about a campaign in 2010 to get fans involved in Earth Hour. Although the effects of WSBC's progress have not yet come to pass, it is more recent than FIBAs. There was no update regarding the impact of FIBA's campaign whereas WSBC's practices will be high impact and showcased on a global stage. Therefore, WSBC was considered to have undertaken more ES advances than FIBA.

Discussion

The literature review revealed that only five sports (golf, surfing, football, sailing, and hockey) have received any sport-specific ES academic attention. It is evident that the quantity of literature on sport-specific ES is extremely limited. Whilst the availability of literature made comparison and exploration of topics difficult, it provided general knowledge of relevant themes. Whilst top drivers were partnerships, governance and strategic choice, lack of resources was the most oft-cited barrier. This indicates that resource-scarcity may not drive isomorphic change in sport but rather prevent it. Overall, the ES progress explored was deemed to be ad hoc in nature, which led to resources being allocated on a case-by-case basis (Baldwin, 2010; Francis *et al.*, 2017; Keogh *et al.*, 2014; Mallen *et al.*, 2010; Minoli, 2018). Strategic ES plans and financial forecasting are considered essential in overcoming barriers and accelerating progress. Currently there is no universally recognized approach to evaluate or measure ES across sport, the depth and breadth of research data and scope is inconsistent. Consistency in measurement is fundamental to the development of this academic field, and further research is needed in multiple directions to contribute to this.

Disparity exists between academic research findings and ES progress amongst IFs. This is highlighted by the lack of correlation between the ES progress made across sports in literature, and in practice. For instance, only two of the HoP's top four sports (sailing and football), received any academic attention. Furthermore, the research that *has* been conducted does not appear to be applied by IFs in practice. This is perhaps because the contexts of the academic findings available are not directly applicable to IFs. In order to accelerate ES progress, the relationship between academia and industry must become more integrated.

The HoP showed that the majority of IFs are not making any ES progress. Consistent with literature, the majority of ES progress that *was* being made was ad hoc in nature. The ES progress tier system revealed that the diffusion of progress is uneven across the OM, suggesting that ES is not the product of

institutional implementation. Although literature asserts that organisational change occurs when ES practices are diffused in a structured manner, this was not the case with IFs (Geeraert *et al.*, 2014; Graham *et al.*, 2018; Smith, 2010). The findings indicate that ES progress is more likely the result of sport-specific strategic choice. Due to their close, interdependent relationship with the natural environment, it was hypothesized that watersports would be the most advanced in terms of ES progress (Gilchrist & Wheaton, 2017; Humberstone, 2011; Krein, 2014). The literature review found this to be true for sailing and surfing, whilst the website analysis found sailing and rowing to be amongst the most advanced, with canoeing sitting in Tier 3. The only water-based sport that was not found to be making progress was swimming. This suggests that ES progress is impacted by the sport's relationship with the environment, but only if the practice of the sport is directly integrated into the natural environment. Olympic swimming for instance, occurs indoors. Therefore, perhaps it is more accurate to state that *open-water* sports are amongst the most advanced in terms of ES progress, as a result of a more direct interdependence on the natural environment than other sports. This does not, however, explain the drivers of ES progress amongst sports that do not share this relationship. Further research into this relationship as well as the drivers of strategic choice across other sports would provide a more holistic view of how to diffuse ES across the OM more efficiently and effectively.

Twitter findings indicated that both ES progress and communication of ES-related activities have increased significantly since 2015. However, the exact nature of the relationship between ES tweets and progress was unable to be identified. Further research could increase the uptake and effectiveness of ES practices by exploring the interdependence of ES progress and communication strategies, developing indicators to eradicate greenwashing or encourage best practices, and understanding the role of communications in ES-based partnerships. Tweets and progress were influenced by external factors. The OG exert influence on IF ES communication, however the strength of this relationship was only partially explored due to an incomplete data set (postponement of Tokyo 2020). Future studies could provide further insight into the ES links between the OG and IFs, contributing to IOC strategic decision-making.

Conversely, no relationship was apparent between interventions and ES progress or tweets. This contradicted the literature findings, which assert that governance impacts the uptake of ES practices. The disparity in these findings could be attributed to the type of interventions explored. The literature determined that economic governance interventions were effective, whereas those analysed were ES-related. Institutional theory held explanatory power to an extent, as it appears that economic-based governance interventions exert more influence than ES-related ones. Further research is required to distinguish between various types of governance interventions and if their impact is uniform across all sports and organisational levels.

The close relationship between societal ES events, and IF ES progress and communication, suggested the presence of agenda

setting. The exact extent to which agenda setting plays a role in IF ES communication and progress remains unclear. The examination of sport-specific ES content across multiple social and mass media platforms would enable a deeper understanding of agenda setting theory in sport. Furthermore, the impact of societal ES events on tweets and progress varied according to event type. Where events were official and politically-rooted, little to no effect was observed. Conversely, informal and public-facing events had significant impacts on the uptake of ES practices. This further develops the argument against governance as a driver of ES progress. However, the full complexity of societal ES events was unable to be captured, as the events selected were among many that occurred globally at the time. Cross-sectional studies would more comprehensively capture the range of societal events surrounding key ES progress decisions and identify which ones exert most influence.

As only Tier 1 and 2 IFs tweeted about reporting, it is clear that engaging in reporting activities impacts ES progress. These findings are consistent with [Scott *et al.* \(2018\)](#) who asserted that accountability is vital in driving ES progress. ES progress would perhaps be accelerated uniformly across the OM if mandatory ES reporting were introduced. To substantiate this, future research could explore the relationship between reporting and the achievement of milestones, and identify the most effective management framework.

Whilst empirically reliable, the literature reviewed was neither up to date nor in the context of IFs and there was not enough data to make any valid conclusions. Twitter is comparatively less reliable, however it provides up to date information that is specific to individual IFs. Websites on the other hand, are more factual and official than social media, but also more up to date than academic literature. The various triangulation measures implemented throughout the paper ensure reliability and factual accuracy, thereby eliminating potential issues in this regard. With the aim of determining the current state of ES, sources that are up to date take priority. Therefore, findings from the website content analysis will be regarded as most accurate, followed by Twitter, then literature. Whilst this made the process of ranking very clear for the majority of IFs, there were instances that required discussion.

Tier 2 ranks FIFA below WR. Although Football received academic attention, the main progress findings were not the product of FIFA's activities. WR posted a significantly higher number of ES tweets than FIFA, however unlike WR, FIFA posted reporting content. Tweet content analysis revealed FIFA's ES practices were event-specific whereas WR consistently championed a sport-specific cause and introduced sustainability awards. This demonstrates that WR is cause-driven and that its efforts are aimed at inducing long-term, sport-wide change. Consequently, this ranking in this tier remained.

Golf received the most academic attention, however again the practices explored might not be credited to the International Golf Federation (IGF). A lack of any ES posts on social media suggests that the IGF is disengaged with ES. Literature indicates that significant ES progress *is* being made across the sport on

a multi-national level. This compares to other Tier 3 IFs such as United World Wrestling (UWW), who only posted once about awareness, and the International Federation of Sport Climbing (IFSC) who's single progress post was related to an isolated, event-specific initiative. It is evident that there are more instances of ES activities across golf than in wrestling or sport climbing. Consequently, the IGF has been ranked 11th, above IFSC and UWW.

There was one piece of academic literature present for hockey, its findings were preliminary and not concerned with the IF ES activities but rather with manufacturing processes ([Al Rashid *et al.*, 2020](#)). Additionally, the extent to which the International Hockey Federation is aware of these advances is unclear. It was concluded that Hockey's rank should not change.

There were seven IFs with no ES-related data whatsoever: Badminton World Federation, International Gymnastics Federation, International Handball Federation, International Shooting Sport Federation, International Tennis Federation, World Karate Federation, and World Skate. The website content analysis revealed that none of these IFs used any terms related to ES, suggesting that there is a lack of awareness of environmental issues. Whilst these could be due to limited resources, attempting to explain their absence of ES progress is purely speculative. Further research is required to explore ES themes with relation to these IFs. As there is no data to distinguish between these IFs, all seven have been ranked equally, in last place. Based on the findings of each research method, and the discussion, [Table 7](#) shows the final ranking of ES Progress amongst IFs.

Conclusions

This paper is one of the first contributions to the field of ES in sport from an IF perspective. It provides a starting point for future research by highlighting the current state of ES progress across the OM. Only five out of the 32 sports had any relevant ES literature. Whilst two out of the five sports covered were watersports (Sailing and Surfing), the total volume of literature about watersports ($n=4$) was less than for the other sports reviewed ($n=9$). The presence of literature was higher for watersports than for all other sports (H1). It was also found that whilst governance, partnerships, and strategic choice were all drivers, resource-related pressures in fact created barriers to ES progress. As only one study in the final sample ([Ratten, 2019](#)) featured ES progress related to an IF, it is unclear whether IFs are aware of advances in relevant sport-specific innovations, potentially providing a barrier to ES progress. Exploration of themes was limited in terms of context, geography, and organisational level. The academic understanding of ES in sport is sparse and shallow, leaving multiple gaps and directions for future research. Overall, there was not enough literature to comprehensively or accurately identify ES progress amongst IFs.

Examination of IF websites revealed a lack of ES awareness and activity amongst the majority. A significant portion ($n=9$) are engaging in activities but without a strategic ES plan. The most advanced IFs in terms of ES progress are athletics and sailing, followed by football and rowing (H2). The HoP and

Table 7. Final International Federation (IF) environmental sustainability progress ranking.

Ranking	IF
1	World Sailing
2	World Athletics
3	World Rowing
4	Federation Internationale de Football Association (FIFA)
5	International Surfing Association
6	International Triathlon Union
7	International Equestrian Federation
8	World Rugby
9	World Taekwondo
10	International Canoe Federation
11	International Golf Federation
12	The International Federation of Sport Climbing
13	United World Wrestling
14	Union Cycliste Internationale
15	International Modern Pentathlon Union
16	International Fencing Federation
17	International Volleyball Federation
18	International Hockey Federation
19	World Archery
20	International Table Tennis Federation
21	International Weightlifting Federation
22	International Judo Federation
23	World Baseball Softball Confederation
24	International Basketball Federation
25	International Swimming Federation
26	Badminton World Federation
	International Gymnastics Federation
	International Handball Federation
	International Shooting Sport Federation
	International Tennis Federation
	World Karate Federation
	World Skate

tier system provide a clear way to visualize ES progress across the OM, and a sound basis for further exploration into the dynamics of ES in sport. Analysis of potential relationships between IF ES Tweets and various external factors revealed

several key findings. IF's ES efforts and engagement in ES communication on Twitter has increased consistently on an annual basis since 2015 (hypothesis 3 [H3]). Despite similarities in trend, the number of ES tweets made by IFs does not correspond to the ES progress made by IFs (hypothesis 4 [H4] and [H5]). ES interventions and formal public events were found to have little to no effect on IF's ES activities over the past decade (hypothesis 6 [H6]). The external factors that exert the most influence IF's ES activities are OGs and informal societal ES events. These findings indicate that public-facing external factors have more impact on IF's ES activities than political or governance-related ones. IFs in higher tiers displayed more engagement with reporting and milestone tweet content. Analysis of weighted content type informed the re-ranking of IFs within each tier according to ES advances.

Strategic choice and the establishment of partnerships with environmental-based organisations were strong drivers of ES progress. Where there is a direct dependent relationship between a sport and the natural environment, the likelihood of strategic choice increases (H1). The role of institutional theory in driving isomorphic change varies according to governance intervention type, with economic incentives appearing to exert a stronger influence than ES-based interventions. The OG enhance ES awareness amongst IFs, whilst informal and public-facing societal ES events positively impact the uptake of ES practices amongst IFs. Resource-scarcity is not a driver of organisational change towards ES, but rather a prominent barrier for IFs. Establishing strategic ES plans was deemed essential to overcome this barrier and ensure consistent, long-term ES progress; however, widespread lack of ES knowledge and expertise often prevented action from being taken.

Further empirical research is required to validate and develop this paper's findings. In order to further develop the field and accelerate ES progress throughout the OM, an impact assessment should be conducted across the gaps highlighted in this paper, to determine which should take priority on the research agenda. The IOC should establish a mandatory annual ES reporting system for IFs to increase accountability. A platform needs to be created to train, support, and accelerate IF ES progress by enabling resources to be shared regarding transferable ES practices related to funding, procurement, and partnerships.

Data availability

Dryad: Olympic International Federation Environmental Sustainability Progress and Social Media Data. <https://doi.org/10.5061/dryad.n2z34tmwh>

This project contains the following underlying data:

- README.docx: Descriptions of the tabs in the data file (Word)
- Sport Sustainability_Progress & Social_Media_Dataset (Excel)

Data are available under the terms of the [Creative Commons Zero "No rights reserved" data waiver](#) (CC0 1.0 Public domain dedication).

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Open Peer Review

Current Peer Review Status: ?

Version 1

Reviewer Report 14 September 2021

<https://doi.org/10.21956/emeraldopenres.15283.r27706>

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Originality and value of the topic

This is an original paper, and the topic is relevant to sport today; there is a paucity of research on sport and environmental sustainability so this paper aids to, in part, fill a void.

Decision

The article requires revisions - it is hoped that the author(s) complete the revisions and resubmit as the manuscript has merit. The revisions needed are in the front end of the manuscript...as the critically important elements from the methods, results, discussion, and conclusion are strong.

Front End

In the Introduction - Background, in the first paragraph:

- It states that "sports whose very existence depends on the ability to directly interact with the natural environment" -clarity is needed as natural resources are essential to conduct sport (not just for some sports) ... i.e an interaction with the natural environment during sport by breathing air when participating (in sport or life)
- The statement about climate change and negative effects is supported with one reference ... it would be stronger if another reference was added from the International Panel on Climate (IPCC) - as the work from this group represents hundreds of researchers/scientists.
- The statement: "in response to accelerating climate change" just gets inserted as an acceleration has not been discussed prior to this point (just add the point early with a reference so the statements flow).
- Table 2 ... add greater commentary concerning the table in the discussion (currently the heading of the table states more than what is in the discussion)

In the Context section, paragraph 1:

- It states that environmental sustainability started in 2010 in the history of the Olympic Movement ... I question this time statement as the Paquette et al paper used in this

manuscript outlines that all of the Olympic Games since 1994 (I believe) has indicated that they are the 'green' Games. So, a focus on environmental sustainability issues began before 2010. This does not mean that the research cannot focus on the past decade (starting in 2010) ... but the historical statement does need to be adapted.

In the Context section, paragraph 2:

- There is a disconnect between the first and third sentences ... indicate how change theories can provide insight into barriers etc. (what do they reveal? And how and why does it apply to the OM).
- When it states: "lack of internal accountability" ... is the discussion about the IOC, the OM, or the IF's?
- This section jumps around with the various topics ... ensure the flow is correct.

In the Context section, paragraph 5:

- You state that "without internal accountability measures, it is difficult to identify the extent to which IFs are engaging in ES practices" ... just because it is not on their website does not mean they do not have internal accountability measures ... so rework to indicate that the websites do not indicate their internal accountability measures ... [transparency may be an issue ... you could ask the IFs about their internal accountability measures and find out .. but that would be another study!].

In the Literature Review section:

- It was stated that: "Evaluating the extent to which each IF is making ES progress requires identification of the barriers, drivers, and ES practices that exist in single-sport contexts. To review large quantities of information and extract the most significant findings, a systematic literature review method was used (Mulrow, 1994)." The issue is that early statements said that you were benchmarking the ES practices of the IFs ... now you have introduced barriers and drivers and stated single-sport context instead of Summer Olympic sports as stated earlier. This is an easy fix ... but needs to be done to ensure clarity concerning the research. The barriers and drivers will not necessarily be on the IF webpages ... so you can state that this type of knowledge is needed to support why benchmarking progress is - or in not - happening.
- The process used to conduct the literature review is strong.
- The flow of the sport specific literature needs a better introduction ... i.e. to state that the work will be organized based on the following sports Next, the topic discussion bounces around in these paragraphs ... perhaps it could be reorganized to outline the barriers first and then the drivers for each sport or introduce the sport and discuss their barriers and drivers ... and state why you are not including the other sports. This means indicating which Summer Olympic sports did not have any literature associated with the sport and ES (how many were not the focus of any of the literature?) - this needs to be discussed in the front end to link to the statements in the back end of this manuscript

Methods

- The approach to hierarchical information is strong and fully referenced.
- What about additional search words in the search ... such as "ecology" and "greening" ... I wonder if additional words would have made a difference in the results?

- The question arises: Can you state that it is a lack of understanding of environmental practices that could be conducted ... just because it is not on the IF website? Or, is this what practices they choose to publish and have not kept their transparent statements up to date? Yes, further research is necessary!

Is the work clearly and accurately presented and does it cite the current literature?

Yes

Is the study design appropriate and is the work technically sound?

Yes

Are sufficient details of methods and analysis provided to allow replication by others?

Yes

If applicable, is the statistical analysis and its interpretation appropriate?

Yes

Are all the source data underlying the results available to ensure full reproducibility?

Yes

Are the conclusions drawn adequately supported by the results?

Yes

Is the argument information presented in such a way that it can be understood by a non-academic audience?

Yes

Does the piece present solutions to actual real world challenges?

Yes

Is real-world evidence provided to support any conclusions made?

Yes

Could any solutions being offered be effectively implemented in practice?

Yes

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Sport environmental sustainability; sport event management; sport ethics

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.