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RUNNING HEAD: ESPORTS ECOLOGY

Do We Need Esports Ecology? Comparisons of Environmental Impacts Between Traditional
Sport and Esports

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Abstract

The impacts of climate change will require a closer examination of esports' environmental impact and how the environment will impact esports. This paper presents a conceptual examination of this bidirectional relationship between esports and the environment by utilizing the framework of sport ecology. Aspects of the Sport Event Environmental Performance Measurement tool and the Climate Vulnerability of Sport Organizations framework may be applicable to esports in future research to better understand this environmental relationship. There are similarities in how live esports events are hosted when compared to traditional sports, but the potential for remote competition does change the dynamic of this environmental relationship. While remote competition can limit environmental exposure and impact, it does potentially create two environmental points of exposure and impact compared to one at an in-person event. More development is required in this space to better understand the role of esports organizations and the nature of esports itself.

KEYWORDS: esports, gaming, sport ecology, environment, sustainability

Introduction

Thanks in part to scientific efforts like those of the most recent Intergovernmental Panel on Climate Change report (IPCC, 2021), there is an abundance of information on the threat that climate change poses to humanity, our societies, and planet. While reports from scientists make predictions of the impact of climate change in the future, it is already being observed today through extreme weather events, loss of biodiversity, rising sea-levels, loss of ice cover, and other ecological disasters that might impact the planet and human activity (c.f., Clarke et al., 2022). As a result of these environmental changes, many industries – including the sport, live events, and gaming industries – are being challenged to better understand their environmental footprint and to mitigate the harmful impacts of their activities. Sport has a fundamental relationship with the natural environment as it requires specific environmental conditions to be met to play (e.g., mountainous terrain with snow for skiing or a field with dry conditions for baseball). At the same time, sport is impacted by changing climates that may make it unplayable which could include a warming climate threatening both skiing conditions and baseball safety (Orr, 2020). There is a growing body of research which considers this relationship between sport and the natural environment (c.f., Mallen, 2018), but more research is needed in this space to safeguard access to sport as well as the viability and profitability of the industry. Further, this research thus far has only considered the relationship between “traditional” sports and the natural environment with no attention having yet been paid to the impact of the emerging field of esports (c.f., Nyström et al., 2022). Given the growth of the esports industry and esports participation, this is a major shortcoming that sport management research focused on the environment needs to address (Nyström et al., 2022).

It is difficult to properly estimate the size of the esports industry due in part to its lack of distinction between publishers who produce the games and the esports-related revenues from those publishers. A 2019 estimate of the industry suggested a value of almost \$25 billion which includes the value of game publishers (Ahn et al., 2020). At this size, it is fair to suggest that esports have an environmental impact given that there are many ways in which the development of games already impacts the environment which therefore contributes to climate change. Such endemic practices result in a measure of impact, including energy for data storage, the use of rare earth elements and minerals, petroleum-based substances, and travel (Gordon, 2020).

Alternatively, esports may be impacted by climate change in a similar fashion to that of traditional sport (Gordon, 2020). Esports may have similarities to that of traditional sports like hosting large spectator events in a venue, yet it also sees esports athletes able to engage in a remote manner through which traditional sports are unable to operate (Jenny et al., 2018). The overarching principles of esports cannot be inherently separated from those of traditional sport, particularly in consideration of the sportification of esports through organization and infrastructure similar to that of its non-digital counterpart (Heere, 2018).

There is potential for overlap and differences between the conceptualizations of sport ecology for traditional sports and what the ecological impact of esports might be, but this has not yet been explored. The dearth of information on esports and their environmental impact is a critical gap – especially as we seek to better understand the industry’s contribution to- and risks faced by- climate change. In response, this paper provides a preliminary conceptual analysis of the similarities and differences in the ecological impact of esports from the perspective of sport ecology. The remainder of this paper will cover sport ecology and the environmental impact of

sport, the esports industry, a perspective on esports ecology, discussion, and conclusions with recommendations for future research in this space.

The Role of Sport Ecology

Since this paper considers the environmental impacts of esports from the perspective of the environmental impacts of traditional sport, it is important to first examine the concept of sport ecology. As a relatively new and growing area of research, sport ecology studies the bidirectional relationship between sport and the natural environment (McCullough, Orr, & Kellison, 2020). The bidirectional nature of this relationship suggests that the two are influencing each other. Sport influences the natural environment to create playing conditions and spectator experiences in a variety of ways: consumption of natural resources, constructing physical infrastructure like stadiums, and creating wastes that must be managed. Alternatively, sport competition and spectator experiences are influenced by the natural environment via climate reliance for competitive conditions and a need to respond to long-term deviations in the climate resulting from climate change. As a context for research, sport ecology has seen a variety of theoretical perspectives and methodological approaches, but comprehensively attempts to answer a question posed by Cachay (1993): how can sport continue to be played in the future given what we know about how it negatively impacts the environment? For reference, some of these negative environmental impacts include, but are not limited to: non-renewable resource extraction, air and water pollution, and interrupting biodiversity to alter landscapes to accommodate sport (c.f., Mallen et al., 2010; McCullough et al., 2020)

We can borrow from current sport ecology literature to develop a profile of those bidirectional environmental relationships that sport has. Beginning with how sport influences the natural environment, the Sport Event Environmental Performance Measurement (SE-EPM) tool

from Mallen, Stevens, Adams, and McRoberts (2010) provides insight into what sport takes from the environment (inputs) and what it gives back to it (outputs). Despite some limitations in the SE-EPM tool, which is based on the original Environmental Performance Measurement tool from Xie and Hayase (2007) having Cronbach's alpha scores for inputs (0.690) and outputs (0.420) short of the criterion from Mahoney and colleagues (1995), it is sufficiently reliable and remains the most comprehensive profile of the environmental impact of sport events and therefore possibly sport as a whole. The SE-EPM suggests that sport events require inputs in the form of natural resources like energy, water, food, raw materials, chemicals, gases, and oils, while also producing outputs as byproducts like solid wastes, liquid discharges, emissions, and other polluting chemicals (Mallen et al., 2010). Table 1 offers a full list of these inputs and outputs from Mallen et al. (2010). The SE-EPM was originally developed for traditional sport and its events, but esports may be able to employ the SE-EPM to build a profile of their ecological relationship. There are some similarities in the hosting of events and differences in the dual dimension of in-person competition and virtual competition (Jenny et al., 2017). One other major shortcoming of SE-EPM is a lack of consideration for climate and the role of climate change. Yet, with no better options for a conceptualization of the impact of sport, this paper uses SE-EPM as a starting point for discussion of the ecological relationship of esports.

The other side of the sport ecology discussion that needs to be addressed is the way in which the natural environment will influence sport – particularly in light of climate change. Traditional sports may require precise environmental conditions in order provide appropriate settings for competition (c.f., Orr, 2020). This means that as the climate changes, it will impact the viability of traditional sports in the form of increased precipitation, extreme heat, and threats to coastal areas from rising sea levels (Orr & Inoue, 2019). The dangers of climate change have

already been noted for traditional sports and events alike: heat and changes to precipitation patterns threatening ski seasons and Winter Olympic Games, or wildfires, tropical cyclones and coastal flooding threatening baseball, Summer Olympic Games, and FIFA Men's World Cups (Orr, 2020; Ross & Orr, 2022). Adaptions that traditional sport will need to consider as part of a changing climate include potentially relocating competition, moving indoors, changing the timing of competition, changes to athlete heat exposure and safety policies, and other adjustments (Orr & Inoue, 2019).

While all valid concerns for the impact of the environment on sport, these sport ecology considerations for the influence of environment and climate change on sport have been developed with the traditional sport industry in mind in a similar fashion to the SE-EPM. It will be possible to borrow from this knowledge to conceptualize the ecological relationship of esports, but there are some differences in that esports mainly competes indoors already and may not be dependent upon precise environmental conditions. Regardless, this sport ecology background is vital for understanding what esports ecology might be since, despite differences between traditional sport and esports, it remains the only theoretical foundation available in sport management literature that is suitable for this subject. Before furthering discussion on the esports ecology, it will first be important to define precisely what is meant by esports in the context of this research.

Esports

Esports, as defined by this manuscript, is an encompassing term for the entities of the competitive video gaming environment including game publishers, athletes, competitive organizations, and third-party vendors who participate in the systems of spectated tournaments, leagues, and events played on personal computers, game consoles, or mobile phones (c.f., Funk

et al., 2018). While all esports are video games, not all video games are esports in much the same sense that anyone can pick up a ball and play a game, but that does not mean that they have engaged in regulated, competitive sport for spectator enjoyment (Funk et al., 2018). Esports have competitive infrastructures that foster athletic talent and, at the upper echelons of its practice, provide a product that is worthy of spectatorship from the audience (e.g., Jenny et al., 2018; Sharpe et al., 2022; Witkowski & Manning, 2019). In other words, esports have experienced ‘sportification’ which makes it appear similar to traditional sport (Heere, 2018). Esports titles often have non-competitive participants, and many like Riot Games’ *League of Legends* generate much of their revenue from their player base and not exclusively from esports activities, which in its current state is unprofitable for many publishers and is seen as a marketing expense (Amenabar, 2021). In comparison to traditional competitive sport, there are many similarities: physical skill-based competition with wide followings and institutional stability (Funk et al., 2018), yet despite the sportification of video gaming into esports, one of the fundamental differences lies in the initial development of esports as a digital and globalized (i.e., athletes can compete at great distances from one another) form of competition whereas traditional sport evolved from a localized and physically interactive form of competition (i.e., athletes must be in the same location to compete) (Scholz, 2021). This being said, major esports tournaments still prefer to compete in-person which will be discussed further on in this section.

Esports can trace its roots to before the 2008 economic crisis, but its current foundations lie in the rise of streaming sites like Justin.tv (now Twitch) that connected gaming tournaments with reliable spectatorship (Taylor, 2018). Though esports at their highest level often involve the in-person tournament scene, the streaming component of esports remains a steadfast support of its environment and regularly brings in millions of viewers for premiere events, including a

record 5,147,701 peak concurrent non-Chinese viewers for the LoL 2022 Worlds Finals (Esports Charts, 2022) and a 37 percent year-over-year increase in hours watched for DotA 2's The Invitational (Murray, 2021). Esports is not necessarily a source of substantial profit for game developers given the expenditures necessary to maintain a competitive ecosystem but is at a basic level a marketing expense for game developers to advertise the often free-to-play games built with cosmetic microtransactions.

Given that esports involve competing in video games on personal devices, one would assume that the environmental effect would be limited to at home power usage, server power usage, and the material mining and development process for computer parts. Esports, however, have a robust system of in-person competitions for regular season, majors, or championship events. Most esports leagues feature in-person LAN events that may be supplemented by limited online competition. In-person events provide event operators with increased revenue opportunities in ticketing, sponsorship activations, and merchandising. Competing offline also provides competitive benefits in the form of ping. Ping is a term to describe the delay between a user's input and the server's response to them (Esports.net, 2021). While to the layman a 50-millisecond ping would seem insignificant, to the professional scene it could mean the difference between victory and defeat. In-person events allow for developers to provide competitors with 0 ping using on-site servers or offline LAN lobbies and is often viewed as the peak environment for competition.

All major esports titles operate in-person events. *League of Legends* operates franchised-regional leagues across continents that compete in studio and often operate regular season championships at a regional venue before sending a few teams to two international events in the summer (Midseason Invitational) and fall (Worlds). The *Call of Duty* League (CDL) utilizes

franchise-hosted majors that travels throughout the season, while *Rocket League* uses online majors to qualify for three in-person international majors. These formats of in-person tournaments supported by online qualifiers are utilized by nearly all major esports titles, including *Counter-Strike: Global Offensive*, *DotA 2*, *Valorant*, *Rainbow Six Siege*, and more.

The context thus far greatly resembles the competitive structures of traditional sports, events that solely take place at arenas, stadiums, and fields. The debate for esports' inclusion into the sport management fold has yielded fruitful conversation, including a 2018 special issue from *Sport Management Review* that provided infrastructural insight into the foundations of esports as a discipline. Esports, like traditional sport, is a multidisciplinary context that features unique phenomena that requires new theory and application, similar to that of sport with management theory. Though the differences and similarities between esports and sport cannot be fully construed given the former's recent development, it could be postulated that the observed phenomena of the esports environment exhibit a sportification of its infrastructure, wherein the systems in place mimic that of traditional sport in operation (Heere, 2018). An esports fan attending an event today will buy tickets for events, wear team apparel, and exhibit team identification all like traditional sports fans. This is further exemplified in the developing players unions, contract law negotiations, franchising agreements, and competitive structures that are emerging in esports that already exist in the leagues of baseball, basketball, and other mainstream sports. Though these examples are not fully fledged in the esports ecosystem yet, the continued development of the esports competitive scene will lead to further mimicking of the traditional sports sphere, just as the operations of new sports leagues morph over time as economic sustainability materializes. Esports stakeholders, then, have benefitted from repurposing the traditional sports infrastructure for their competitions, with some leagues like the

Overwatch League (OWL) and the CDL, both run by Activision Blizzard, utilizing localization in the forming of their franchisees (Atlanta FaZe, Toronto Ultra, Shanghai Dragons, Paris Eternal, etc.). Esports fans develop relationships with teams similar to traditional sport, and esports franchises that utilize localization can develop fans with stronger identification and emotional connection to the team (Hwang et al., 2022).

Esports Ecology

Building from the foundations of sport ecology, conceptualizing the ecological relationships of esports, as defined by the parameters of this manuscript, will also require bidirectional considerations. This manuscript will first consider the environmental impact of esports and then follow with the impact of the environment upon esports.

Esports Impact on the Environment

In terms of the competition of esports, it largely mirrors that of traditional sport with the notable exception of the possibility for remote competition where teams may compete collectively online despite physically being in different locations. At the elite levels of esports, in-person competitions are preferred and may be held in public assembly venues with the competitions broadcast to an audience beyond the venue itself (Chaloner, 2020). Due to these similarities with traditional sport, the application of the SE-EPM inputs and outputs may be appropriate as the nature of the events and competition is comparable. In-person esports events require electricity, water, raw materials, food, chemicals, and other natural resources that take from the environment for the running of the venue and event, as well as accommodating competitors, officials, and spectators as part of the event. As examples of this, electricity will be needed to power the building as the hardware required for esports, and fuel will be burned as part of the transportation of people and materials to the event. For the outputs, these in-person esports

events will create byproducts in wastes and emissions that will have an impact on the environment. Any fuels burned in transporting people and materials to the esports event will create emissions (e.g., carbon dioxide, sulphur dioxide, and nitrogen oxides) that harm our climate and ozone layer. Events also create trash and recyclables from persons at the event which must be disposed of properly to avoid burdening the ecosystem with more human-generated wastes. All of these inputs and outputs are those described in the SE-EPM tool (Mallen et al., 2010).

In-person events may be similar to traditional sport, and there are even some esports titles that mimic traditional sports like EA Sports' Madden and FIFA or Formula E's esports competition (c.f., Robeers & Van Den Belck, 2018), but the possibility of remote competition does make a large difference in the environmental impact of esports. Transportation is considered one of the greater harms to the environment as its activity is one of largest contributors of greenhouse gases accounting for 27 percent of all emissions (EPA, 2022). It has been estimated that spectator travel to a single sport event may contribute up to 55 % of total greenhouse gas emissions (Collins et al, 2009) with athlete- and team-related travel in the area of 24 % of their greenhouse gas emissions (Dolf & Teehan, 2015). With in-person competition preferred, the environmental impacts of travel are similar to that of traditional sports. Yet, remote competition eliminates the need for competitors to travel long distances to one another to compete as well as for spectators to travel to the events. This greatly reduces travel times to only local commutes with spectators observing via broadcast or streaming, and thus decreases the contribution to greenhouses gases that esports requires. Streaming is already the preferred method for spectator consumption of esports (Wohn & Freeman, 2020). Broadcasts and streaming do come with their own set of environmental challenges (Lopera-Mármol & Jiménez-

Morales, 2021). That being said, traditional sports are also consumed by some spectators through broadcast and streaming (or in the case of the Tokyo 2020 Olympics almost entirely through broadcast and streaming), but from the standpoint of the actual competition, this is something that traditional sport is unable to do since traditional sports require competition to take place in-person in all instances of individual, dueling, and team sports.

One other area of environmental impact for esports concerns its use of hardware and software. For esports to exist, each video game must be developed. The industry of video game development is estimated to cost 34 terawatt hours of energy per year which is similar to the energy consumption of 5 million automobiles (Gordon, 2020). With new editions of consoles, new versions of software, and patches frequently being released by developers, this is a cycle that should expect to continue in the future (Patterson & Barratt, 2019). Much of the hardware required utilizes rare elements, minerals, and petroleum-based substances (particularly plastics) that require mining and extraction (Gordon, 2020). These materials are then shipped globally (contributing the harmful transportation emissions) for assembly, distribution, and use. The constant upgrade cycle means potentially non-recyclable materials are constantly sourced, used, and destroyed (Patterson & Barratt, 2019). This is not to suggest that traditional sports do not require equipment or software for competition (e.g., competitive equipment, venue equipment, data analytics, broadcast and streaming, among other technological needs), but in esports there may be a greater emphasis on the development of hardware and software as part of competition (Chaloner, 2020). One final hardware and software issue to consider is that video games accumulate and store vast amounts of data via their connectivity, data exchange, and high-definition streaming. This requires a considerable amount of electricity to power servers that may produce several hundred tons of carbon emissions annually for each server farm (Gordon, 2020).

These server farms must be built and expanded as increasingly more internet-connected users come online with increasingly more data-demanding needs that contribute to internet pollution.

Part of the discussion on the impact of esports on the environment must address climate change. To date, esports' contribution to climate change has been overlooked and possibly downplayed (Abraham, 2020), but it is still a contributor to climate change given that it requires environmental resources and creates environmental byproducts such as those listed measured by the SE-EPM tool. Perhaps in recognition of this need, the Global Esports Federation and United States Esports Association are signatories to the United Nations Sport for Climate Action Framework. Based on the above discussion related to event inputs and outputs, travel, electricity demand, and use of raw materials, Dyer-Witthford and de Peuter (2021) as well as Gordon (2020) both suggest that esports and video game development have a unique contribution to climate change. All of these discussed environmental impacts are harmful and their presence adds to the global environmental destruction that is causing climate change.

Impact of the Environment on Esports

The other side of the bidirectional ecological relationship is how esports will be impacted by the natural environment. Everyday weather as well as local climate and geographic features (e.g., terrain, temperature, precipitation, and air quality) largely do not impact esports given its indoor and digital nature. This differs from some outdoor sports like surfing, skiing, golf, or baseball that depend upon certain environmental conditions for play. Aside from a powerful storm or natural disaster knocking out the electricity required to play or other required infrastructure and mobility (i.e., internet connectivity), it is hard to predict how those local climate and geographic features influence esports. Additionally, those natural disasters are not unique to esports since they would also influence traditional sport (i.e., a hurricane would wipe

out all infrastructure rather than discriminating between traditional sport and esports infrastructure).

Perhaps the largest impact of the environment on esports is how esports organizations and competitions will be impacted by climate change. The Climate Vulnerability of Sport Organizations (CVSO) framework from Orr and Inoue (2019) provides an understanding of how sport organizations may be impacted by climate change. The CVSO was created for traditional sport organizations and utilizes the concepts of climate vulnerability, exposure, sensitivity, and adaptive capacity to conceptualize organizations' ability to respond to climate change (Orr & Inoue, 2019). Those concepts inform climate impact on the organization (CIO) and organizational capacity for change (OCC) which are then used in tandem to propose four states for a sport organization to exist within with regard to climate vulnerability. Given the focus on organizations, it is possible to utilize CVSO to examine esports organizations to determine their states one of the four: Problem (high CIO; low OCC), Redundant (low CIO; high OCC), Responsive (low CIO and OCC), or Fortified (high CIO and OCC) (Orr & Inoue, 2019). Problem states have high climate risk but no organizational capacity to react, redundant states have low climate risk but high organizational capacity to react, responsive have low climate risk and potentially just enough organizational capacity to react, while fortified states have high climate risk but high organizational capacity to react (Orr & Inoue, 2019). The optimal states for organizations would be either of responsive or fortified states since both have either mitigated the risks or have the potential to do so while a problem state is unprepared for the risks they face and redundant states are inefficient with their resources (Orr & Inoue, 2019). Esports organizations will need to consider how changes in terrain, temperature, precipitation, and air

quality will impact their organizational operations and whether they are prepared to mitigate these risks. Their decision on climate change would therefore impact esports as a whole.

Moving into specificities rather than considering the organizational impacts, there are two major concerns for the impacts of climate change on esports. The first concerns how environmental conditions will evolve as a result of climate change. Research in sport ecology (e.g., Orr, 2020; Ross & Orr, 2022) has already made projections for the impacts of climate change on traditional sports like baseball and skiing as well as sport events like the Olympic Games and FIFA Men's World Cups. If traditional sport participation and observation opportunities are limited as a result of harmful climate conditions, it is possible that those participants and consumers will be driven to esports since it is environmentally controlled and not influenced as strongly by changing conditions. Though there is no research that has sought clarification on this matter, athletes such as footballer Sergio Aguero, driver Lando Norris, American footballer Boston Scott, and basketballer Jeremy Lin have all experimented with the streaming and esports scenes to varying degrees. Though the examples given do not reflect change from climate conditions, they do represent a change in motivation and support for the idea of traditional athletes activating into the esports ecosystem. The second concern for esports from climate change is the damage that rising sea-levels might cause to coastal internet infrastructure (Gordon, 2020). Much of the infrastructure that connects the world via the internet, a critical piece of infrastructure that esports are particularly dependent upon, is built near coastlines as cables on the ocean floor carry internet access from continent to continent. Additionally, in coastal cities, the fiber-optic cables that connect the city to the internet are often weather-proof, but not water-proof (Jochem, 2018). Rising sea-levels may inundate that infrastructure, disrupt internet connections, and therefore interrupt esports. Given today's

scientific certainty on anthropogenic climate change, the esports industry will need to consider its climate risk and adapt in the future – either to growth in participation and observation or threats to dependent infrastructure.

Discussion

The most important contribution(s) of this paper is an expansion of sport ecology to encompass the ecological relationship of esports and its effort to address a lack of knowledge on environmental topics within the industry (c.f., Ross & Mercado, 2020). Compared to the bidirectional relationship of traditional sport with the environment (c.f., McCullough et al, 2020), the bidirectional relationship of esports with the environment is quite similar at a fundamental level, but does present some differences operationally due to the potential for an indoor, digital, and remote competition (Jenny et al., 2018). Examining esports broadly, one can see that esports requires the consumption of environmentally sensitive resources while creating environmentally harmful byproducts (e.g., wastes and discharges, emissions, and chemical pollutants) like those found in Mallen and colleagues (2010) SE-EPM. Esports will also be threatened by environmental dangers (e.g., natural disasters and climate change), but is not as severely impacted by the day-to-day changes in weather that some traditional sports may face due to the indoor, digital, and potential for remote competition in esports. If one chooses to examine esports only from the event standpoint or even the potential for esports to be competed in a purely indoor environment, then they are subject to an extremely similar ecological relationship to that of other indoor and climate-controlled sports like basketball and futsal. As a result of this, it could be suggested that esports may not need to be treated differently with regard to their bidirectional relationship with the environment from that of traditional sport.

The digital and remote nature of esports presents a different operational picture of the bidirectional relationship of esports to the environment (c.f., Jenny et al., 2018). The potential for athletes to compete in separate geographical locations along with spectators consuming the event digitally from their own chosen locations (similarly to traditional sport consumers watching a television broadcast) does imply that travel and event environmental impacts are decreased, but this does not take away from the fact that these competitions still require resource consumption (e.g., electricity consumed and raw materials for equipment) and byproduct creation (e.g., emissions from generating electricity or materials disposed of after use). In this case, the SE-EPM may still yield valuable insights into one half of the bidirectional relationship, but does not provide an understanding of the other half of the bidirectional relationship. The impact of the environment on esports in this digital and remote setting may be implied to be smaller due to a lack of a large-scale spectator event in a public assembly venue for the environment to influence, but it could also imply that there are now two different environmental settings to consider and two potential targets for environmental harms. In this regard, esports ecology may require the development of a bidirectional ecological relationship that is distinct from that of traditional sport.

One concern that esports ecology raises with regard to the whole picture of sport ecology is the need to better understand the process by which traditional sport has moved into an indoor, climate-controlled, artificial environment from an outdoor, climate-dependent, and natural environment (Orr et al., 2020). Research from Orr, Ross, and Pelcher (2020) is starting to consider this process, but esports provide a new dimension to this research since they have wholly existed in the indoorized, climate-controlled, and artificial environment rather than having started in nature and transitioned indoors. There is room for growth in this area of

research moving forward since it impacts the relationship of sports and esports with the environment but also the operations and decision-making of events and venues when accounting for a lack of natural elements. This is not to be confused with the notion of sportification (c.f., Heere, 2018) in which esports has moved from a recreational activity to a more professionalized and regulated sport setting, but rather that traditional sport has moved from competing in nature to competing in climate-controlled settings.

There is also a question of what is encompassed in the context of the word “esports”. This manuscript intentionally used a narrow definition of esports in order to provide a solid foundation to begin examining the relationship between esports and the natural environment. In doing so, it likely misses some key points about the ecological relationship of game development and casual gaming, but these are avenues for the future expansion of esports ecology research. However, in studying esports, we must consider the nature of a tournament and league scene, an omnipresent diaspora, that at times overshadows the smaller amateur scenes – similarly to how the professionalized traditional sport setting overshadows amateur traditional sport. Esports as a field of study also may include the behaviors of game developers not exclusively dedicated towards esports, such as the development of new characters, maps, and items for all users of the game. Esports may also consider the vibrant streaming scene of content creators that play esports titles but not for competitive gains. A question to ask based on this is: could the ranked gameplay of a 15-year-old in Rocket League on a PS4 at home be a part of that calculation? Some of these issues are easier and some are more serious in nature but the line of thinking illustrates how the sphere of esports influence and the video games industry in general are so intertwined that researchers must think carefully about the variables and populations that would constitute a valid perspective. A better definition of esports matters for the true understanding of its ecological

relationship because we must define at what point we can stop the lifecycle assessment chain of interpreting environmental impact. Thus, future research does need to consider the expansion of esports ecology to include more of the amateur and casual gaming settings to develop a more complete understanding of this ecological relationship. Specific decisions on what is or is not included may vary based on the research design, goals, and subject matter of future esports ecology studies.

Finally, the SE-EPM tool is useful in discussing the impact that sport and esports has on the environment, but only accounts for one half of the bidirectional relationship: how the environment impacts sport and esports (Mallen et al., 2010). It is also limited in its approach by only examining resource consumption and byproduct creation, which does not account for changes in landscapes, access, biodiversity, social consequences of environmental management, and other worthy points of consideration in environmental management and ecological relationships. The SE-EPM is also only one possible tool for measuring the environmental impact of sport. Other potential tools include life cycle assessments (i.e., carbon footprint analysis) and input-output modeling (Collins et al., 2009). Future research in esports ecology ought to consider examining its environmental impact through the use of these tools. The other half of the relationship is best understood via Orr and Inoue's (2019) Climate Vulnerability of Sport Organizations framework. The combination of SE-EPM and CVSO is useful in examining the whole picture of the ecological relationship of both sport and esports and may begin to address the shortcomings in tracking and measurement of sport and environment noted by Mallen (2018). Yet, it should be noted that further development of tracking and measurement of environment in sport and esports is required to build a more robust understanding of the bidirectional relationships.

Conclusion

This paper presented an initial conceptual examination of the bidirectional relationship between esports and the environment from the perspective of (traditional) sport ecology. This requires expansion in future research due to limitations from our narrow definition of esports. Revisiting the question posed by the title of this manuscript (do we need esports ecology?) the answer appears to be uncertain but trending towards “yes.” There are similarities to live events, competitions, and organizations, all the while esports has an intrinsically digital identity and a unique potential for remote play in an indoor, climate-controlled, and artificial environment which differentiates it from traditional sport. Thus, it is important to consider this digital infrastructure as part of its ecological relationship. Despite these differences we can be assured that esports impacts the environment and may be impacted by its environment – especially in light of climate change. Understanding and acting upon this bidirectional relationship requires further development by both researchers and practitioners alike. Thus, while this paper offers the groundwork for esports ecology, more work will be needed to empirically measure esports environmental impact, ensure that esports decrease their environmental impact, that they are prepared for the impacts of climate change.

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Table 1

SE-EPM Environmental Input and Output Items from Mallen et al (2010)

<u>Input Measures</u>	<u>Output Measures</u>
Oil use (kl)	General waste disposal (ton)
Gas use (m ³)	Industrial waste disposal (ton)
Electricity use (kWh)	Carbon dioxide emission (CO ₂ per ton)
Water use (m ³)	Sulphur dioxide emission (kg)
Raw material use	Nitrogen oxide (NO _x) emission (kg)
Paper use (ton)	Biochemical oxygen demand (kg)
Packaged material use (ton)	Chemical oxygen demand (kg)
Chemical use (kg)	Water drainage (ton)
Food consumption (lbs)	Pollutant Release and Transfer Release (PRTR) chemicals released (kg)
	PRTR chemicals transferred (kg)
