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COMMENTARY

A call for more physiology at conservation conferences

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Abstract Scientific conferences are more impactful when they foster novel ideas, create new networks, and promote inter-disciplinary collaboration. The field of conservation physiology is inherently cross-disciplinary, representing the application of physiological techniques and knowledge to address conservation issues. Ideally, knowledge transfer comes from both directions: conservation biologists seek input on physiological techniques that can contribute to the success of their programs, and physiologists collaborate with conservation biologists to plan relevant applications for their work. To assess whether the level of integration between conservation and physiology has been increasing since the formal naming of the discipline of conservation physiology in 2006, we reviewed abstracts from conferences of three societies: Society for Conservation Biology (SCB), Society for Integrative and Comparative Biology (SICB), and Society for Experimental Biology (SEB). Specifically, we searched for physiology-related keywords in abstracts from SCB meetings, and for conservation-related keywords in abstracts from SICB and SEB. Our results indicate that the percentage of presentations incorporating physiology at conservation meetings has remained relatively steady (2–3%). In contrast, the percentage of presentations citing conservation applications has been rising at both of the integrative biology societies' meetings and has reached 4.4 and 7.9% at SICB and SEB, respectively. We provide suggestions for why there may be discrepancies between conference types and ways to encourage the presence of physiological topics at future conservation meetings.

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Introduction: conservation physiology entails cross-disciplinary collaboration

Conservation physiology is a discipline characterized by a union of techniques, theory, and action that seeks to identify and solve conservation problems through the application of physiological concepts and tools (Wikelski and Cooke 2006; Cooke et al. 2013). Much of the power of physiology for conservation lies in its sensitivity, providing an early warning signal of disturbance. This sensitivity not only indicates that a conservation issue is present, it can also pinpoint how to solve it (i.e., isolate the cause) and allow for the lead time to accomplish mitigation effectively. For example, an understanding of the nutritional physiology of the desert tortoise (*Gopherus agassizii*) allowed managers to determine that population declines were primarily due to high potassium loads in their food source, as opposed to increased predation, disease, habitat encroachment, or poaching as originally thought (Oftedal 2002; Van Devender 2002). This information allowed conservation efforts to be targeted at maintaining adequate food sources by controlling livestock grazing (Oftedal 2002). In addition, by measuring cortisol levels in the claws of bats (*Myotis lucifugus*) exposed to the fungus that causes white-nose syndrome, Davy et al. (2016) discovered cryptic physiological carry-over effects that could affect population viability even after bats are recovered and asymptomatic (i.e., when other non-physiological metrics may not indicate a problem). Similarly, the sensitivity of physiological indicators such as stress hormone levels and body condition allowed Janin et al. (2011) to ascertain that landscape modification (habitat availability and fragmentation) was impacting a population of American toads (*Bufo bufo*) where traditional occurrence data could not. As a result, physiological information often allows conservation managers to work proactively to mitigate disturbances prior to population decline.

Although the field of conservation physiology has been accumulating success stories (i.e., tangible contributions to conservation initiatives; Madliger et al. 2016), and integration has been growing since the discipline was formally described in 2006 (Lennox and Cooke 2014), there are still a number of barriers that can impede knowledge transfer and collaboration (Cooke and O'Connor 2010; Lennox and Cooke 2014; Coristine et al. 2014; Madliger and Love 2015). Importantly, the success of the discipline rests on the ability to correctly identify how physiological approaches can contribute to specific conservation problems and this necessitates knowledge of: (i) the underlying physiological systems and how they can be measured, and (ii) the scope of the conservation issue, its history, and any limitations of implementing potential management techniques. This can be a tall order given that many conservation scientists are not necessarily formally trained in physiology and vice versa (Cooke and Suski 2008; Cooke and O'Connor 2010). As a result, formal connections between conservation scientists and physiologists are often the only way to bring together the expertise necessary to accomplish the on-the-ground successes that the field of conservation physiology aspires to attain (Coristine et al. 2014).

One key venue for new collaborative opportunities is scientific conferences. Scholarly and intellectual meetings (organized by professional societies, academic entities, government, etc.) enable individuals to develop or expand their networks, while also providing

opportunities to learn about new techniques and inspire new avenues in research programs. Importantly, scientific meetings permit face-to-face planning of projects and interacting in-person is especially important for developing trust and understanding among collaborators (Alberts 2013). Beyond this, scientific meetings can provide a way for early career researchers (e.g., graduate students and post-docs) to become exposed to new sub-disciplines to which they can contribute as they forge their academic and career paths. Finally, novel science occurs most freely at conferences if they promote "random collisions of ideas and approaches" (Alberts 2013). Therefore, conferences that are designed to increase exposure of their attendees to new techniques and paradigms have the greatest chance of stimulating success; the field of conservation physiology can only grow more diverse and successful if conservation scientists and physiologists gain exposure to one another's research limitations, strengths, and potential.

Assessing integration across conference types

We investigated the level of integration between physiology and conservation at the annual scientific meetings of three prominent societies: (1) Society for Conservation Biology (SCB), which hosts some of largest and most important meetings of conservation scientists in the world (Society for Conservation Biology 2016); (2) Society for Integrative and Comparative Biology (SICB), which hosts a major conference attended by North American ecological, evolutionary, and comparative physiologists; and (3) Society for Experimental Biology (SEB), which hosts a major conference attended by European ecological, evolutionary, and comparative physiologists. Specifically, we searched the abstracts of symposia, plenary, and contributed oral presentations (and, in some cases, poster presentations where these could not be distinguished—see Table 2 in Appendix) for 21 keywords related to physiology at SCB meetings and 25 keywords related to conservation at SICB and SEB meetings (Table 1). We focused on all meetings with available abstract books (obtained online or through contact with the society) from 2007 onward (Table 2 in Appendix) to focus on the time period since the formal naming of the discipline of conservation physiology (Wikelski and Cooke 2006). Importantly, because some of the search terms can be used in contexts other than conservation or physiology, and because not every presentation at SICB and SEB falls under the umbrella of physiology, we confirmed that each instance of a keyword represented a relevant integration of the two disciplines. In addition, if an abstract contained multiple keywords, we assured it was counted only once. In total, we searched 6843 abstracts from 8 meetings of SCB, 7366 abstracts from 9 meetings of SICB, and 2925 abstracts from 7 meetings of SEB (Table 2 in Appendix).

At the start of the search period (2007/2008), the percentage of cross-disciplinary abstracts was similarly low across all three conference types (SCB: 2.3%; SICB: 1.3%; SEB: 1.7%; Fig. 1). To determine whether the percentage of cross-disciplinary abstracts has been increasing over the previous 10 years at each meeting type, we performed separate linear regression analyses with year as the independent variable and percentage of abstracts as the dependent variable. The percentage of abstracts constituting conservation physiology research has increased through time at SICB ($F = 17.13$, $p = 0.004$, $r^2 = 0.71$, $n = 9$) and SEB ($F = 8.69$, $p = 0.03$, $r^2 = 0.63$, $n = 7$) meetings, but not at SCB conferences ($F = 0.60$, $p = 0.47$, $n = 8$) (Fig. 1). The total percentage of cross-disciplinary abstracts also varied among conference types, ranging from 2.0 to 3.0% at SCB, 1.3 to 4.4% at SICB, and 1.7 to 7.9% at SEB (Fig. 1). Importantly, SICB and SEB conferences include topics beyond physiology (e.g., cell biology, pedagogy, kinematics, agriculture), and we did not specifically partition out physiology presentations (i.e., all

Table 1 Conservation keywords used for searches of abstracts in conference programs of the Society for Integrative and Comparative Biology (SICB) and Society for Experimental Biology (SEB), and physiology keywords used for searches of conference abstracts from the Society for Conservation Biology (SCB)

Conservation keywords	Physiology keywords
Biodivers*	Biochem*
Biological diversity	Bioenerg*
Captive breeding	Cort*
Climate change	Ecophysiol*
Conserv*	Endocrin*
Decision	Energ*
Endangered	Epidem*
Enhance*	Gas exchange
Ex situ	Gluco*
Extinct*	Hormon*
Extirpat*	Immun*
Habitat loss	Metab*
Imperiled	Neurophys*
In situ	Nutrit*
Introduc*	Oxidative
Invasive	Photosynth*
Manage*	Physiol*
Policy	Respir*
Preserv*	Sensory
Protect*	Stress
Recovery	Telemetry
Restoration	
Species at risk	
Threaten*	
Translocat*	

Asterisks indicate wildcard characters

presentations across the entire complement of subjects were searched for conservation physiology topics and divided by the total number of abstracts to obtain percentages). As a result, the percentage of inter-disciplinary presentations is likely an underestimation in the case of both SICB and SEB, further indicating that cross-disciplinary presentations are more common at these venues.

Encouraging more physiology at conservation meetings

Our simple investigation into inter-disciplinary integration at professional scientific fora revealed that conservation scientists attending one of the largest conference venues for their field have not been exposed to a great deal of physiological content over the past 10 years, despite the growth in the field of conservation physiology. We consider this to be unfortunate; conservation challenges are increasing in number and scope and a diverse arsenal of tools should only be a benefit when tackling issues across species, ecosystems, and social systems (Salafsky et al. 2002). We do not intend to imply that the conference organizers associated with SCB have actively discouraged physiology from their meetings. Instead, part of the explanation for our results may lie in the differing barriers experienced by conservation scientists compared to physiologists when viewing their research in an

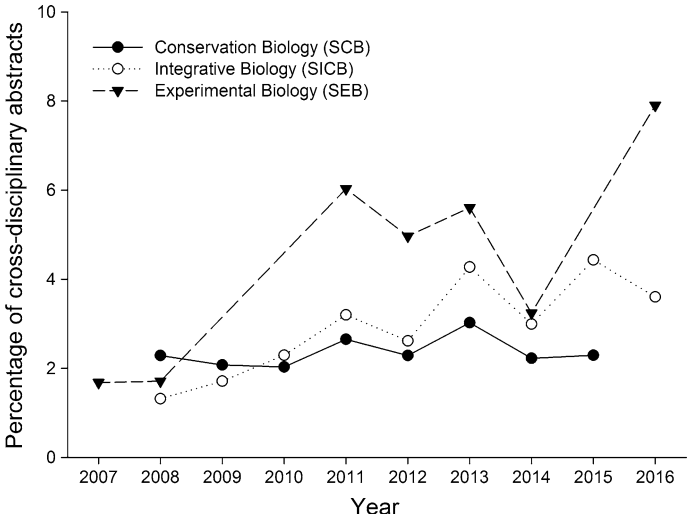

Fig. 1 Percentage of abstracts that integrate physiology and conservation at conferences held by the Society for Conservation Biology (SCB), Society for Integrative and Comparative Biology (SICB), and Society for Experimental Biology (SEB) between 2007 and 2016. Searches were based on keywords related to physiology and conservation (Table 1) and were limited by program availability (i.e., full lists of abstracts were not available for each society's annual meeting across the full range of years)

inter-disciplinary light. For example, many ecological physiologists may have gained skills through their undergraduate and/or graduate degrees in concepts that will serve them well when communicating and planning with conservation scientists such as ecosystem functioning, animal handling, and basic principles of ecology and life history. In contrast, many conservation scientists may not have gained experience in physiological lab and field techniques, constraints related to sampling requirements, or interpretation of physiological metrics across diverse ecological and evolutionary contexts. As a result, being in the latter situation may be more intimidating when initiating inter-disciplinary projects than the former. It may also be easier to cite implications of physiology research in the context of climate change or anthropogenic disturbance than to consider how physiology may be able to contribute to resolving a conservation problem. Many ecological physiologists will have experience considering the applications of their research as these statements are important for acquiring funding and promoting their research to public audiences. On the contrary, conservation scientists would rarely be in a position that would require them to formulate how physiology could benefit their research goals.

We suggest a number of avenues to achieve a greater level of integration of physiology into conservation meetings. In the case of both SICB and SEB, conservation physiology presentations have been on the rise in part because of dedicated symposia focused on the topic. In contrast, none of the meetings of SCB that we analyzed included a symposium structured around the discipline of conservation physiology. As a result, we encourage conservation physiologists to propose symposia at future SCB meetings that highlight not only the tools available in the field, but the types of conservation issues that have been successfully tackled, or can potentially be managed, by incorporating a physiological perspective. Ideally, such symposia would be cross-cutting, perhaps focusing on emerging conservation threats or considering the various mechanisms (genetic, behavioural, physiological, etc.) underlying population declines. In addition, including managers and

practitioners that have successfully collaborated with physiologists (i.e., who have achieved a conservation success via an integrative approach) would be particularly worthwhile for illustrating the power of a cross-disciplinary approach. Furthermore, including representatives from funding agencies in symposia could also encourage more diverse funding opportunities. SCB meetings are also often characterized by diverse, well-organized workshops and those working within the realm of physiology could propose to lead a workshop designed to introduce concepts, networking opportunities, or specific tools. These types of events would be similarly interesting to physiologists who may be looking to connect with conservation professionals, but have not yet had the opportunity, particularly those that may be just beginning their research program.

Conservation scientists planning symposia focused on a specific species, conservation issue, or management approach could also target a physiologist as a potential speaker, where relevant. Recently, it was noted that conservation genetics, another multi-disciplinary field, has been facing presentations being siloed into topic-specific sessions at conservation conferences, creating an environment where many conservation scientists who work outside of genetics likely do not get exposed to new techniques and their potential to aid in their questions (Taylor and Soanes 2016). When incorporating more physiological approaches, we echo (Taylor and Soanes 2016) in stating that presentations should focus not just on the technique, but on the conservation problems that can be solved by employing it to ensure as diverse an audience as possible.

SCB regularly provides the opportunity for meeting attendees to offer feedback regarding conference experiences (through online surveys and by encouraging participants to make contact with congress organizers during or after meetings). We urge attendees to take advantage of this opportunity and be vocal if they have interest in being exposed to more conservation physiology topics. For example, the society currently does not offer a keyword related to physiology when submitting abstracts, which could leave physiologists feeling as if their research may not fit within the mandate of the society. SCB also often solicits suggestions for plenary speakers, providing the opportunity for potential attendees to offer names of leaders in the field of conservation physiology. Finally, regardless of meeting type, we urge conference attendees to consider how their abstracts are prepared and which type of audience they seek to attract. While it can be commonplace to focus on the physiological technique utilized, a presentation can attract a far more diverse audience if focus is also placed on the type of issue or management practice that is relevant (e.g., pollution, habitat loss, restoration, captive breeding).

While our assessment of integration is focused on large international conferences, it is important that conservation biologists and physiologists continue to engage in cross-disciplinary collaboration at multiple levels of scientific exchange. For example, smaller (e.g., regional or taxa-specific) meetings can represent equally productive avenues for stimulating inter-disciplinary projects, and can also attract a larger constituent of non-academic attendees. Integration can also be promoted during the training of undergraduate and graduate students at academic institutions by including conservation-focused lecture material in physiology classes and vice versa (Cooke and O'Connor 2010), inviting integrative speakers for seminars, hiring faculty in conservation biology departments whose research foci include ecological/conservation physiology and vice versa, and promoting inter-disciplinary graduate student committees.

Scientific conferences will be most impactful when they foster novel ideas, create new networks, and promote inter-disciplinary collaboration. Overall, greater integration of physiology at conservation meetings will occur if: (1) conference organizers actively work to encourage the participation of physiologists, and (2) physiologists take the initiative to attend and engage. With limited travel budgets, there are only so many opportunities for expanding conference attendance, but we urge conservation physiologists to consider SCB meetings for themselves and the early career researchers that they mentor, while also continuing to contribute to the integrative and experimental biology conferences at which they have been increasingly present. We acknowledge that being introduced to new material and making new connections at conferences has the potential to spark a project, but successful collaboration will require ongoing cooperative planning with stakeholders (Cooke et al. 2012), communication across disciplines, and an underlying motivation to venture into new research territories. Overall, as dedicated researchers across an entire spectrum of conservation sub-disciplines, greater exposure and collaboration will only benefit us when approaching the diverse conservation challenges we face.

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Appendix

The societies, venues, types of abstracts (oral/poster), and number of abstracts for conference programs we searched can be found in Table 2.

Table 2 Meeting types, venues, types of abstracts, and number of abstracts for programs available from Society for Conservation Biology (SCB), Society for Integrative and Comparative Biology (SICB), and Society for Experimental Biology (SEB) between 2007 and 2016

Society	Meeting[a]	Venue	Total abstracts	Abstract types searched	Number of conservation physiology abstracts	Percentage of conservation physiology abstracts
Conservation Biology	ICCB 2008	Chattanooga, Tennessee, USA	656	Oral and poster	15	2.3
	ECCB 2009	Prague, Czech Republic	578	Oral	12	2.1
	ICCB 2010	Edmonton, Alberta, Canada	689	Oral	14	2.0
	ICCB 2011	Auckland, New Zealand	792	Oral and poster	21	2.7
	NACCB 2012	Oakland, California, USA	437	Oral	10	2.3
	ICCB 2013	Baltimore, Maryland, USA	1058	Oral and poster	32	3.0

Table 2 continued

Society	Meeting[a]	Venue	Total abstracts	Abstract types searched	Number of conservation physiology abstracts	Percentage of conservation physiology abstracts
	NACCB 2014	Missoula, Montana, USA	584	Oral	13	2.2
	ICCB/ ECCB 2015	Montpelier, France	2049	Oral and poster	47	2.3
Integrative and Comparative Biology	SICB 2008	San Antonio, Texas	608	Oral	8	1.3
	SICB 2009	Boston, Massachusetts	759	Oral	13	1.7
	SICB 2010	Seattle, Washington	785	Oral	18	2.3
	SICB 2011	Salt Lake City, Utah	625	Oral	20	3.2
	SICB 2012	Charleston, South Carolina	803	Oral	21	2.6
	SICB 2013	San Francisco, California	960	Oral	41	4.3
	SICB 2014	Austin, Texas	969	Oral	29	3.0
	SICB 2015	West Palm Beach, Florida	858	Oral	38	4.4
	SICB 2016	Portland, Oregon	999	Oral and poster	36	3.6
Experimental Biology	SEB 2007	Glasgow, Scotland	595	Oral and poster	10	1.7
	SEB 2008	Marseille, France	292	Oral and poster	5	1.7
	SEB 2011	Glasgow, Scotland	365	Oral	22	6.0
	SEB 2012	Salzburg, Austria	403	Oral	20	5.0
	SEB 2013	Valencia, Spain	464	Oral	26	5.6
	SEB 2014	Manchester, England	401	Oral	13	3.2
	SEB 2016	Brighton, UK	405	Oral	32	7.9

Note that all program books included oral, plenary, and symposia presentations

[a] The Society for Conservation Biology hosts different types of meetings based on location that vary based on year: *ICCB* International Congress for Conservation Biology, *ECCB* European Congress for Conservation Biology, *NACCB* North American Congress for Conservation Biology

References

Alberts B (2013) Designing scientific meetings. Science 339:737. doi:10.1126/science.1236324
Cooke SJ, O'Connor CM (2010) Making conservation physiology relevant to policy makers and conservation practitioners. Conserv Lett 3:159–166. doi:10.1111/j.1755-263X.2010.00109.x
Cooke SJ, Suski CD (2008) Ecological restoration and physiology: an overdue integration. BioScience 58:957–968. doi:10.1641/B581009
Cooke SJ, Hinch SG, Donaldson MR et al (2012) Conservation physiology in practice: how physiological knowledge has improved our ability to sustainably manage Pacific salmon during up-river migration. Philos Trans R Soc B Biol Sci 367:1757–1769. doi:10.1098/rstb.2012.0022
Cooke SJ, Sack L, Franklin CE et al (2013) What is conservation physiology? Perspectives on an increasingly integrated and essential science. Conserv Physiol. doi:10.1093/conphys/cot001
Coristine LE, Robillard CM, Kerr JT et al (2014) A conceptual framework for the emerging discipline of conservation physiology. Conserv Physiol. doi:10.1093/conphys/cou033
Davy CM, Mastromonaco GF, Riley JL et al (2016) Conservation implications of physiological carry-over effects in bats recovering from white-nose syndrome. Conserv Biol. doi:10.1111/cobi.12841
Janin A, Léna J-P, Joly P (2011) Beyond occurrence: body condition and stress hormone as integrative indicators of habitat availability and fragmentation in the common toad. Biol Conserv 144:1008–1016. doi:10.1016/j.biocon.2010.12.009
Lennox R, Cooke SJ (2014) State of the interface between conservation and physiology: a bibliometric analysis. Conserv Physiol. doi:10.1093/conphys/cou003
Madliger CL, Love OP (2015) The power of physiology in changing landscapes: considerations for the continued integration of conservation and physiology. Integr Comp Biol 55:545–553. doi:10.1093/icb/icv001
Madliger CL, Cooke SJ, Crespi EJ et al (2016) Success stories and emerging themes in conservation physiology. Conserv Physiol. doi:10.1093/conphys/cov057
Oftedal OT (2002) Nutritional ecology of the desert tortoise in the Mohave and Sonoran deserts. In: Van Devender TR (ed) The Sonoran desert tortoise. University of Arizona Press, Arizona, pp 104–241
Salafsky N, Margoluis R, Redford KH, Robinson JG (2002) Improving the practice of conservation: a conceptual framework and research agenda for conservation science. Conserv Biol 16:1469–1479. doi:10.1046/j.1523-1739.2002.01232.x
Taylor HR, Soanes K (2016) Breaking out of the echo chamber: missed opportunities for genetics at conservation conferences. Biodivers Conserv 25:1987–1993. doi:10.1007/s10531-016-1159-x
Van Devender TR (2002) The Sonoran desert tortoise. University of Arizona Press, Arizona
Wikelski M, Cooke SJ (2006) Conservation physiology. Trends Ecol Evol 21:38–46. doi:10.1016/j.tree.2005.10.018