Received: 22 February 2022 | Revised: 1 June 2022 | Accepted: 3 June 2022
DOI: 10.1111/fme.12579

REVIEW

Fisheries Management and Ecology
WILEY

Effect of wind speed and light intensity on reflex impairment of angled Smallmouth Bass (*Micropterus dolomieu*)

Nick Forgues | Luc LaRochelle | Declan Burton | Steven J. Cooke

Fish Ecology and Conservation Physiology Laboratory, Department of Biology, Carleton University, Ottawa, Ontario, Canada

Correspondence
Luc LaRochelle, Fish Ecology and Conservation Physiology Laboratory, Department of Biology, Carleton University, 1125 Colonel By Dr., Ottawa, ON K1S 5B6, Canada.
Email: larochelle96@gmail.com

Abstract

We quantified effects of wind speed and sunlight on Smallmouth Bass (*Micropterus dolomieu*), a popular gamefish in North America, after catch-and-release (C&R) ($n = 90$) during August for various periods (0, 10, 30 and 90 s) in direct sunlight or shaded from direct sunlight. We evaluated change in skin temperature and reflex action mortality predictor (RAMP) scores. Changes in skin temperature were larger with increasing wind speeds and air exposure duration. Light intensity had no effect on skin temperature or RAMP. Generally, skin temperature decreased (i.e. colder) when wind speed exceeded ~5 km/h and increased (i.e. warmer) when wind speed was below ~5 km/h. Significantly, lower RAMP scores were associated with longer air exposure. Generally, Smallmouth Bass exposed to air for longer than 10 s were significantly more impaired prior to release. We recommend anglers reduce the time that large fish are exposed to air to reduce immediate reflex impairment.

KEYWORDS
air exposure, catch-and-release, environmental factors, *Micropterus dolomieu*, reflex impairment, warm

1 | INTRODUCTION

Recreational catch-and-release (C&R) fishing is a pastime enjoyed globally with growing participation that generates significant socio-economic benefits (Arlinghaus et al., 2015; Arlinghaus et al., 2021). Angler motivation behind releasing captured fish is often due to their conservation ethic or to comply with fishing regulations (Cooke & Schramm, 2007). Fisheries can benefit from C&R as a management tool, but fish must survive the angling interaction (i.e. no post-release mortality) and released fish must suffer no negative consequences to their fitness (Arlinghaus et al., 2007; Bartholomew & Bohnsack, 2005). Nonetheless, much effort is devoted to reducing mortality and sublethal consequences. Best management practices and fish handling practices have been developed to guide anglers on proper gear selection, fish handling and general stewardship to help minimise mortality from C&R angling (Brownscombe et al., 2017; Cooke & Suski, 2005; Elmer et al., 2017). One aspect of C&R events that has been particularly well studied is air exposure (Cook et al., 2015).

Air exposure is often the most challenging aspect of a C&R event for fish (Cook et al., 2015; Cooke & Suski, 2005). Fish exposed to air are no longer able to uptake oxygen from their surrounding environment due to collapse of their gill lamellae (Ferguson & Tufts, 1992). Air-exposed fish experience multiple changes, such as lowered heart rate, elevated cortisol levels, decrease in blood pH, and ion imbalances, the severity of which depends on the duration of air exposure (Cook et al., 2015; Ferguson & Tufts, 1992). Physiological alterations arising from air exposure can contribute to reflex impairments (e.g. loss of equilibrium and inability to burst swim; Davis, 2007; Brownscombe et al., 2015), which indicates that fish are exhausted (Davis, 2010). Fish with reflex impairments arising from air exposure and other aspects of fishery interactions tend to exhibit behavioural alterations (Brownscombe et al., 2013, McLean et al., 2020; Raby et al., 2014). Reflex impairments are predictive of the long-term fate or mortality of fish (Davis, 2010; Humborstad et al., 2009; Morfin et al., 2019).

The body of work assessing effects of fisheries-related air exposure has focused largely on documenting effects of different air exposure durations, with little effort to understand how different environmental conditions during air exposure influence outcomes for fish. One study revealed that skin temperature was positively related to windchill for Largemouth Bass angled in winter (LaRochelle et al., 2021). Sunlight also causes an increase in body and skin temperatures of ectotherms (such as herptiles) exposed to the sun while basking in air (Boyer, 1965; Porter & Gates, 1969; Hertz, 1992). Such research is lacking for fish, although presumably fish in direct sunlight during air exposure may also experience similar effects. In water, sun-basking fish achieve body temperatures higher than ambient water conditions (Nordahl et al., 2018), thereby demonstrating that such changes are likely in air. Furthermore, if air exposure periods for fish (i.e. duration thresholds) are regulated, best management practices must also consider environmental conditions during air exposure periods as environmental factors during air exposure events could exacerbate negative effects on welfare of released fish.

Using Smallmouth Bass (*Micropterus* dolomieu), a popular recreational sportfish as a model (Quinn & Paukert, 2009), we evaluated effects of wind speed and light intensity during air exposure on skin temperature and reflex impairment of angled Smallmouth Bass. We anticipated that Smallmouth Bass exposed to sunlight (with greater light intensity) would have warmer skin temperatures than those exposed to lower light intensity. Additionally, we expected that Smallmouth Bass exposed to higher wind speed would experience a greater change in skin temperature than fish not exposed to air (Ortega et al., 2017; Stevenson, 1985). Fisheries managers will be able to use information gained from this study to further inform best management practices for fish handling and thereby allow them to create practices that maximise fish welfare by implementing regulations or recommendations that are based on thresholds for air exposure periods over a range of environmental conditions.

2 | METHODS AND MATERIALS

2.1 | Fish capture

Smallmouth Bass were captured during 15–19 August 2021 from Big Rideau Lake, Ontario, Canada (44°44′59.9 N, 76°13′60.0 W). Where Smallmouth Bass were captured, surface water temperatures ranged 26–27°C and wind speeds ranged 0–15 km/h (mean = 7 km/h). All fish were captured using 213 cm medium action fishing rods equipped with 4.5–9.0 kg braided fishing line. Smallmouth Bass were captured using Ned rigs, drop shots, spy baits and jerk-baits. Once a fish was landed, the hook was removed (standardised to 10 s), and the fish was immediately placed into a water-filled trough with fresh lake water that was added to the trough using bucketed surface water. Smallmouth Bass were then measured in total length (mm) and tagged with an anchor tag. The period spent in the water-filled trough was standardised to 5 s. Deeply hooked fish were removed from the study to reduce possible effects of deep hooking on reflex impairment.

Once the Smallmouth Bass was removed from the trough, the skin temperature was immediately recorded from between the pectoral and caudal fins using an infrared temperature meter (±1°C, AstroAI), which was standardised to 2 s of air exposure prior to starting treatments. Following the initial skin temperature measurement, fish were air exposed for a duration corresponding to the selected treatment. During air exposure, light intensity (lux; accuracy ±5% lux, Dr.meter, LX1330B, Union City, California) was measured from directly beside the fish. The maximum wind speed (km/h) was measured using a portable weather station (wind speed ±5%, Hold Peak, Zhuhai, China) for the duration of the treatment.

2.2 | Treatments

Smallmouth Bass were exposed to air for one of four durations, 0, 10, 30 or 90 s, assigned in a rotational pattern to ensure randomness of data collection. Duration times were chosen to cover the range of time an average angler uses to release a fish back into the water with common practices (Gingerich et al., 2007). Besides the control group (0 seconds), each of the time groups were divided into two subgroups, one in direct sunlight for the duration of air exposure and the other shaded beneath a piece of cardboard.

2.3 | Reflex assessment

Following air exposure, skin temperature was measured again, and the fish was then immediately placed into a livewell (95 litres) with fresh ambient lake water to assess and score reflex action mortality predictors (RAMP; Davis, 2010). Ventilation, fin erection, equilibrium, tail grab and the bite reflex were used to test impairment of each fish (Raby et al., 2012). RAMP tests were performed in the same order for all fish. Fish that passed a reflex test (i.e. showed a response) were assigned a score of 1, for a total of 5 points, whereas response failure was assigned a score of 0 for that reflex (see Davis, 2010; Raby et al., 2012). Ventilation was scored positive if the opercula opened and closed in a rhythmic manner. Fin erection was scored positive if the spiny dorsal fin was erected when the fish was held in water. Equilibrium was scored positive if a fish returned to an upright position (i.e. ventral side down) within 3 s after being turned upside down (i.e. ventral side up). Tail grab was scored positive if a fish attempted to escape the grasp of its caudal peduncle. Bite reflex was scored positive if a fish closed its jaw within 2 s after inserting a finger into its mouth.

2.4 | Data analysis

Analyses used R Studio (version 1.4.1717) running R (4.1.1). Fish length was tested as a potential covariate in each model. A one-way ANOVA was used to test for differences in fish length, wind speed and light intensity among treatments (aov function). A linear model

TABLE 1 Number, mean length and length range of Smallmouth Bass (*Micropterus dolomieu*) groups exposed to different durations of air exposure (treatments)

Treatment	*n*	Mean (mm) ± SD	Smallest (mm)	Longest (mm)
Control	13	316 ± 54	255	421
10-s Air exposure	25	324 ± 59	256	450
30-s Air exposure	26	313 ± 49	262	402
90-s Air exposure	26	315 ± 47	270	448

was fit with change in skin temperature (ΔSkin) as the response variable and treatment, wind speed and light intensity as predictor variables (lm function). This model was then analysed with an ANOVA to explore which predictor variables significantly influenced skin temperature. The change in skin temperature (ΔSkin) was calculated by subtracting the skin temperature before air exposure from the skin temperature after air exposure. Due to a lack of significant relationship between light intensity and delta skin temperature model (see results below), fish from light versus shade treatment were aggregated into single groups for air exposure durations (4 treatments—control, 10, 30 and 90 s). A one-way ANOVA was fit with the direction of the skin temperature change as the response variable and wind speed as the predictor variable to determine whether wind speed influenced the direction of skin temperature change. A general linear mixed model was used with RAMP as the response variable and air exposure duration, Δskin and fish length as predictors (glm [gaussian] function). Wind speed covaries with Δskin, so was not included in this model. Significant predictor variables were compared using a Dunnet post hoc test (glht function). Statistical significance was assessed at $\alpha = 0.05$.

3 | RESULTS

3.1 | Fish metrics

Ninety Smallmouth Bass (mean ± (SD) total length (TL) = 318 ± 52 mm, 250–450 mm range) were caught, measured and each subjected to a treatment (Table 1). Smallmouth Bass length ($F_{86,3} = 0.189$, $p = 0.903$) and light intensity ($F_{81,3} = 1.981$, $p = 0.123$) did not differ significantly among exposure periods (treatments). However, wind speed differed significantly between exposure periods ($F_{86,3} = 3.233$, $p = 0.026$). Smallmouth Bass that were removed from the water for 90 s experienced significantly greater wind speed than the control group ($t_{3,1} = 2.502$, $p = 0.035$).

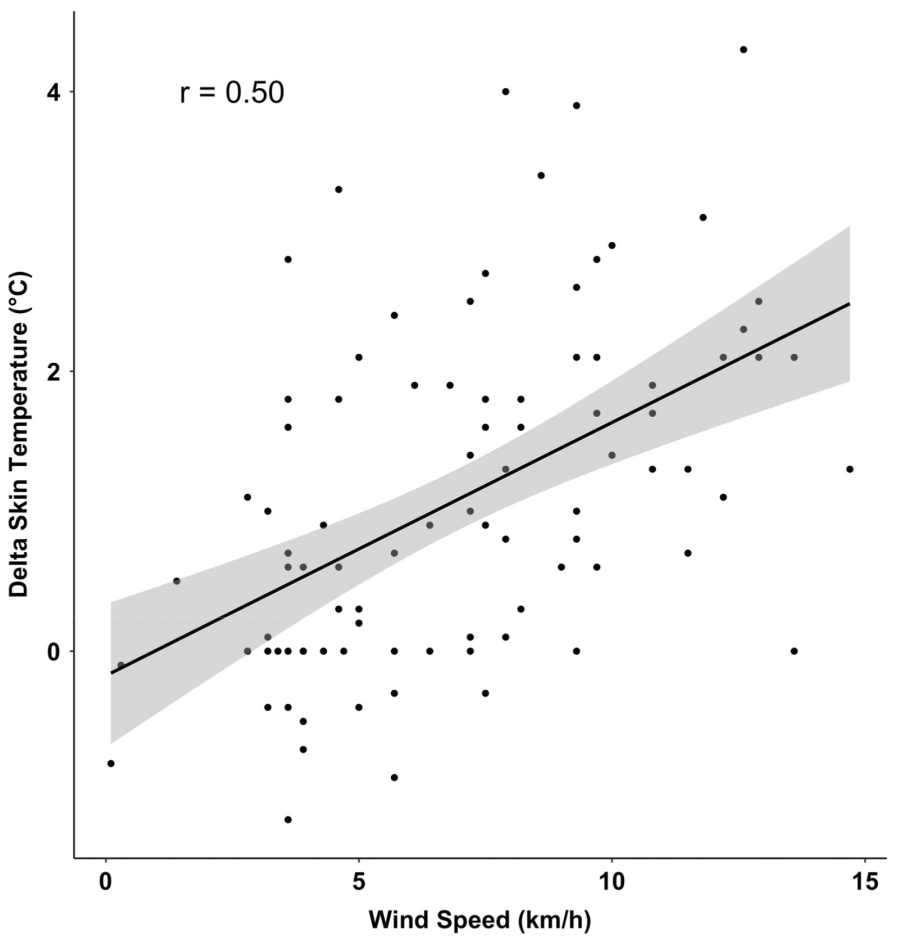

FIGURE 1 Linear relationship between change in skin temperature of Smallmouth Bass (*Micropterus dolomieu*) and wind speed ($y = -0.174 + 0.181x$). The r value represents the correlation coefficient between wind speed and skin temperature change

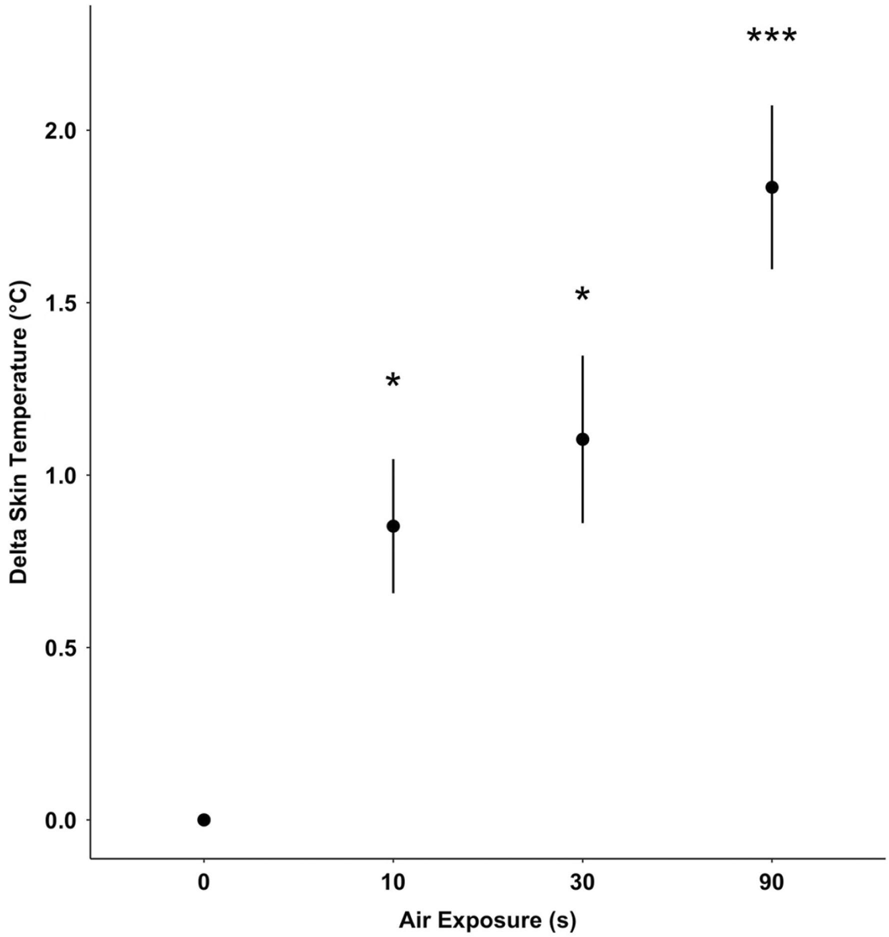

FIGURE 2 Change in skin temperature (Δskin) of Smallmouth Bass (*Micropterus dolomieu*) exposed to different durations of air exposure (s). Asterisks represent significant differences between treatment and control groups (0 s of air exposure)

3.2 | Skin temperature

Change in skin temperature (Δskin) of Smallmouth Bass was significantly influenced by wind speed ($F_{78,1}$ = 18.924 $p<0.001$, r^2 = 0.39). Larger changes in skin temperature were associated with higher wind speeds (Figure 1). Smallmouth Bass length was not significantly related to Δskin ($F_{78,1}$ = 0.02, p = 0.887, r^2 = 0.39). Furthermore, light intensity was not significantly related to Δskin ($F_{78,1}$ = 0.706, p = 0.403). Air exposure duration did not significantly influence Δskin ($F_{78,1}$ = 10.05, $p<0.001$). Change in skin temperature (Δskin) differed significantly between the control group and 10-s ($t_{3,1}$ = 2.403, p = 0.044), 30-s ($t_{3,1}$ = 2.479, p = 0.037) and 90-s ($t_{3,1}$ = 3.951, $p<0.001$; Figure 2) exposure groups. The direction of skin temperature change was significantly influenced by wind speed ($F_{74,2}$ = 48.924 $p<0.023$). Skin temperature significantly decreased when exposed to higher wind speeds ($t_{3,1}$ = −4.025, $p<0.001$), and skin temperature increased (i.e. warmer) when wind was minimal (Figure 3).

3.3 | RAMP scores

The Δskin of Smallmouth Bass was not significantly related to their RAMP score ($t_{84,1}$ = −0.664, p = 0.509). Smallmouth Bass length was significantly related to a decline of RAMP scores ($t_{84,1}$ = −3.159, p = 0.002), with larger fish having lower RAMP scores (i.e. more impairment). Air exposure duration significantly affected RAMP score (Figure 4). Fish that were air exposed for 10 s did not significantly differ from those in the control group (z = −1.656, p = 0.203). However, Smallmouth Bass that were air exposed for 30 s (z = −3.097, p = 0.005) and 90 s (z = −2.912, p = 0.009) had significantly lower ramp scores than the control group.

4 | DISCUSSION

Change in skin temperature was similar for small and large Smallmouth Bass, unlike an earlier study that found a negative relationship between skin temperature and size of Largemouth Bass in winter (LaRochelle et al., 2021). Differences may be due to the subfreezing temperature in the previous study, which exacerbated effects of windchill on body temperature. The change in skin temperature of Smallmouth Bass we found during air exposure was influenced by wind speed, like previously for Largemouth Bass (LaRochelle et al., 2021), which suggests that wind speed influenced skin temperature change when exposed to air. The amount of air passing over an ectotherm's skin increases with wind speed, thereby leading to water loss and subsequent temperature decline as water

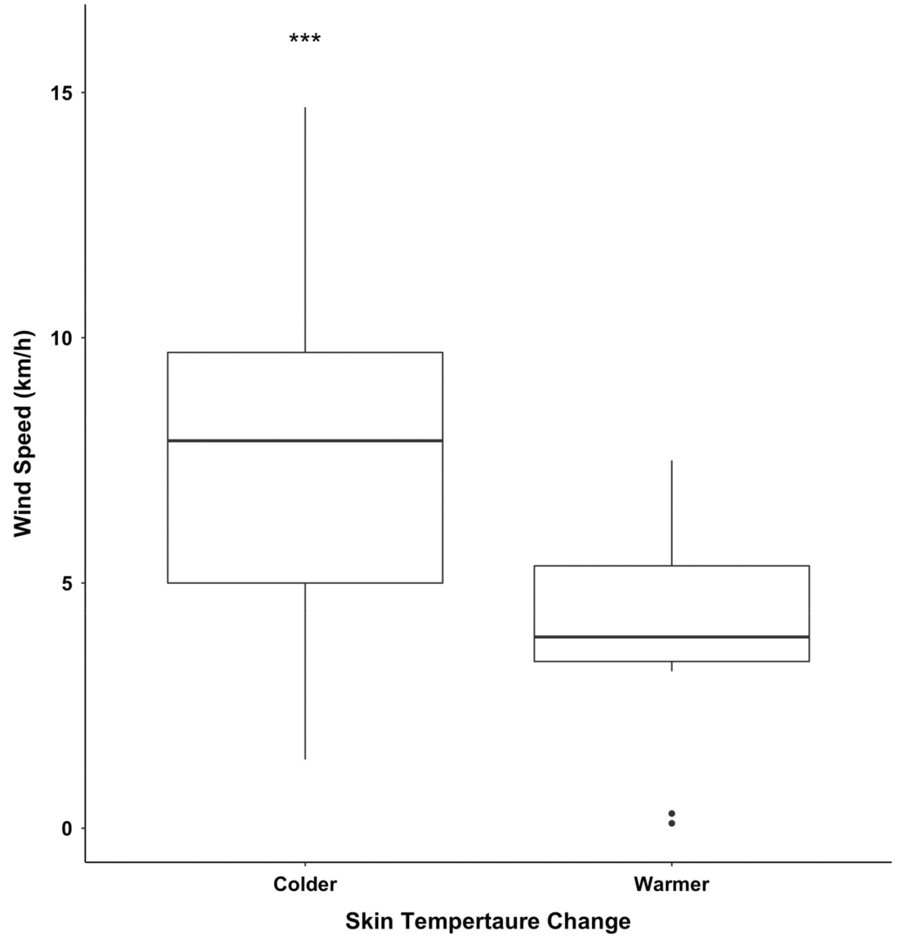

FIGURE 3 Direction of skin temperature change (i.e. lost heat or gained heat) of Smallmouth Bass (*Micropterus dolomieu*) exposed to air for 10, 30 or 90 s in relation to wind speed. Asterisks represent significant differences

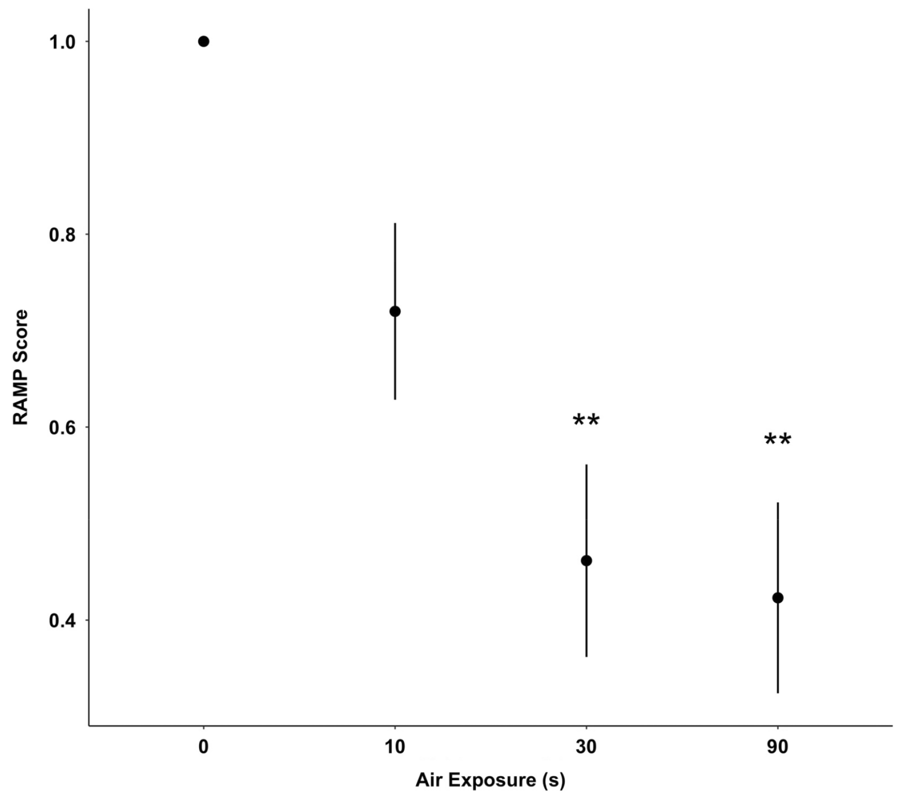

FIGURE 4 Reflex action mortality predictor (RAMP) scores of Smallmouth Bass (*Micropterus dolomieu*) exposed to different durations of air exposure. Asterisks represent significant differences in RAMP score for respective air exposure durations compared with the control treatment (0 s)

no longer insulates heat (Winne et al., 2001). Similarly, our study indicated that wind speeds greater than ~5 km/h reduced skin temperature of fish, whereas skin temperature tended to increase when wind speeds were below ~5 km/h. Further research is needed to determine whether dryness of a fish's skin influences the change in skin temperature. Light intensity from the sun did not significantly influence skin temperature over short periods of exposure to air. In contrast, light intensity influenced body temperature of basking turtles over periods much longer than we studied (Porter & Gates, 1969).

Humidity would likely play an important role in skin temperature change, which could also influence how light intensity influences skin temperature of fish. In our study, cardboard held above fish for shade may have inadvertently redirected some wind flow back onto the fish, thereby increasing the maximum wind speed and decreasing fish skin temperature more than for fish not shaded by cardboard. Although our study was only over a period of 4 days in August, weather conditions were representative of typical summer conditions in which Smallmouth Bass are captured and exposed to air by angling in their native range. Few studies have previously investigated the influence of environment factors on fish during air exposure, so any new knowledge is valuable for anglers to maximise welfare of released fish. Therefore, we suggest further study that incorporates more weather conditions over more seasons (i.e. spring, summer, fall and winter) to determine the combined influence of windchill, humidity, wind speed and light intensity on skin temperature change and reflex impairment of fish prior to release. Best management practices should aim to inform anglers to minimise handling times and air exposure duration when winds are elevated, because wind reduces skin temperature of fish that influences post-release behaviour of fish (LaRochelle et al., 2021). Further research should also investigate the influence of increased skin temperature on fish.

We found that reflex impairment of larger Smallmouth Bass was greater than for smaller fish, perhaps because smaller fish are easier to handle and unhook than larger fish (Gould & Grace, 2009). Duration of air exposure is directly associated with physiological impairments and delayed mortality (Cook et al., 2015; Davis, 2005; Davis & Ottmar, 2006). We found that air exposure duration was inversely related to reflex impairments, with both 30-s and 90-s groups more impaired than the control group. Insignificance of the 10-s group could be that Smallmouth Bass can tolerate brief air exposures without major impairment. Limited air exposure is supported by findings of previous studies (Brownscombe et al., 2017) and best C&R practices (i.e. Keep-Fish-Wet). In trophy fisheries, fish with large bodies are often caught and handled, so fisheries managers should consider size-specific regulations that deter anglers from removing fish from the water, to avoid size-specific reflex impairments and increased air exposure periods associated with longer handling of larger fish that is also related to increased impairment.

Future studies should examine physiological changes associated with skin temperature change when exposed to elevated wind speeds and windchill over a wide range of temperatures (i.e. subfreezing temperatures and extreme warm temperatures). Furthermore, development of a best practice or a device to shelter fish from wind while exposed to air may also increase survival. Our results suggest that skin temperature change is influenced by wind speed experienced during air exposure, where greater wind speeds reduce skin temperature and lower wind speeds increase skin temperature of Smallmouth Bass in the warm season of the year. Furthermore, larger fish tend to have greater immediate reflex impairments, with Smallmouth Bass held out of the water for greater than 10 s having significantly more impairment. Education efforts should encourage anglers to return larger fish to the water as fast as possible to avoid reflex impairment. Furthermore, anglers should also attempt to shelter fish from wind when removed from the water (i.e. unhooking, measuring and photographing) to mitigate change in skin temperature.

ACKNOWLEDGEMENTS

We would like to thank Laura Haniford for the help with data collection. All research were conducted with a Scientific Collection Permit from the Ontario Ministry of Natural Resources and Forestry and an Institutional Animal Care and Use Committee (110558). We would like to thank the reviewers for their suggestions.

CONFLICT OF INTEREST

The authors have no conflict of interest to declare.

DATA AVAILABILITY STATEMENT

CSV file of the data will be made available by requesting it from the corresponding author.

ORCID

Luc LaRochelle https://orcid.org/0000-0002-7058-4852

REFERENCES

Arlinghaus, R., Aas, Ø., Alós, J., Arismendi, I., Bower, S., Carle, S. et al. (2021) Global participation in and public attitudes toward recreational fishing: International perspectives and developments. *Reviews in Fisheries and Aquaculture.*, *29*(1), 58–95.

Arlinghaus, R., Cooke, S.J., Lyman, J., Policansky, D., Schwab, A., Suski, C. et al. (2007) Understanding the complexity of catch-and-release in recreational fishing: An integrative synthesis of global knowledge from historical, ethical, social, and biological perspectives. *Reviews in Fisheries Science.*, *15*(1–2), 75–167.

Arlinghaus, R., Tillner, R. & Bork, M. (2015) Explaining participation rates in recreational fishing across industrialised countries. *Fisheries Management and Ecology.*, *22*(1), 45–55.

Bartholomew, A. & Bohnsack, J. (2005) A review of catch-and-release angling mortality with implications for no-take reserves. *Reviews in Fish Biology and Fisheries.*, *15*(1–2), 129–154.

Boyer, D.R. (1965) Ecology of the basking habit in turtles. *Ecology*, *46*(1–2), 99–118.

Brownscombe, J.W., Danylchuk, A.J., Chapman, J.M., Gutowsky, L.F. & Cooke, S.J. (2017) Best practices for catch-and-release recreational fisheries – Angling tools and tactics. *Fisheries Research.*, *186*(1), 693–705.

Brownscombe, J.W., Griffin, L.P., Gagne, T., Haak, C.R., Cooke, S.J. & Danylchuk, A.J. (2015) Physiological stress and reflex impairment of recreationally angled bonefish in Puerto Rico. *Environmental Biology of Fishes*, *98*(11), 2287–2295.

Brownscombe, J.W., Thiem, J.D., Hatry, C., Cull, F., Haak, C.R., Danylchuk, A.J. et al. (2013) Recovery bags reduce post-release impairments in locomotory activity and behavior of bonefish (*Albula* spp.) following exposure to angling-related stressors. *Journal of Experimental Marine Biology and Ecology*, *440*(1), 207–215.

Cook, K.V., Lennox, R.J., Hinch, S.G. & Cooke, S.J. (2015) Fish out of water: How much air is too much? *Fisheries*, *40*(9), 452–461.

Cooke, S.J. & Schramm, H.L. (2007) Catch-and-release science and its application to conservation and management of recreational fisheries. *Fisheries Management and Ecology.*, *14*(2), 73–79.

Cooke, S.J. & Suski, C.D. (2005) Do we need species-specific guidelines for catch-and-release recreational angling to effectively conserve diverse fishery resources? *Biodiversity and Conservation*, *14*(5), 1195–1209.

Davis, M.W. (2005) Behaviour impairment in captured and released sablefish: Ecological consequences and possible substitute measures for delayed discard mortality. *Journal of Fish Biology.*, *66*(1), 254–265.

Davis, M.W. (2010) Fish stress and mortality can be predicted using reflex impairment. *Fish and Fisheries.*, *11*(1), 1–11.

Davis, M.W. (2007) Simulated fishing experiments for predicting delayed mortality rates using reflex impairment in restrained fish. *ICES Journal of Marine Science.*, *64*(8), 1535–1542.

Davis, M.W. & Ottmar, M.L. (2006) Wounding and reflex impairment may be predictors for mortality in discarded or escaped fish. *Fisheries Research.*, *82*(1–2), 1–6.

Elmer, L.K., Kelly, L.A., Rivest, S., Steell, S.C., Twardek, W.M., Danylchuk, A.J. et al. (2017) Angling into the future: Ten commandments for recreational fisheries science, management, and stewardship in a good Anthropocene. *Environmental Management.*, *60*(2), 165–175.

Ferguson, R.A. & Tufts, B.L. (1992) Physiological effects of brief air exposure in exhaustively exercised rainbow trout (*Onocorhynchus mykiss*): Implications for "catch and release" fisheries. *Canadian Journal of Fisheries and Aquatic Sciences.*, *49*(6), 1157–1162.

Gingerich, A.J., Cooke, S.J., Hanson, K.C., Donaldson, M.R., Hasler, C.T., Suski, C.D. et al. (2007) Evaluation of the interactive effects of air exposure duration and water temperature on the condition and survival of angled and released fish. *Research*, *86*(2–3), 169–178.

Gould, A. & Grace, B. (2009) Injuries to barramundi Lates calcarifer resulting from lip-gripping devices in the laboratory. *North American Journal of Fisheries Management*, *29*, 1418–1424.

Hertz, P.E. (1992) Temperature regulation in Puerto Rican Anolis lizards: A field test using null hypotheses. *Ecology*, *73*(4), 1405–1417.

Humborstad, O.B., Davis, M.W. & Løkkeborg, S. (2009) Reflex impairment as a measure of vitality and survival potential of Atlantic cod (*Gadus morhua*). *Fishery Bulletin*, *107*(3), 395–402.

LaRochelle, L., Chhor, A.D., Brownscombe, J.W., Zolderdo, A.J., Danylchuk, A.J. & Cooke, S.J. (2021) Ice-fishing handling practices and their effects on the short-term post-release behaviour of largemouth bass. *Fisheries Research*, *243*(5), 1–9.

McLean, M.F., Litvak, M.K., Stoddard, E.M., Cooke, S.J., Patterson, D.A., Hinch, S.G. et al. (2020) Linking environmental factors with reflex action mortality predictors, physiological stress, and post-release movement behaviour to evaluate the response of white sturgeon (*Acipenser transmontanus* Richardson, 1836) to catch-and-release angling. *Comparative Biochemistry and Physiology, Part A: Molecular and Integrative Physiology.*, *240*(7), 1–17.

Morfin, M., Kopp, D., Benoît, H.P. & Méhault, S. (2019) Comparative assessment of two proxies of fish discard survival. *Ecological Indicators*, *98*, 310–316.

Nordahl, O., Tibblin, P., Koch-Schmidt, P., Berggren, H., Larsson, P. & Forsman, A. (2018) Sun-basking fish benefit from body temperatures that are higher than ambient water. *Proceedings of the Royal Society B: Biological Sciences*, *285*(1879), 20180639.

Ortega, Z., Mencía, A. & Pérez-Mellado, V. (2017) Wind constraints on the thermoregulation of high mountain lizards. *International Journal of Biometeorology*, *61*(3), 565–573.

Porter, W.P. & Gates, D.W. (1969) Thermodynamic equilibria of animals with environment. *Ecological Society of America.*, *39*(3), 227–244.

Quinn, S. & Paukert, C. (2009) *Centrarchid fisheries. Centrarchid fishes: Diversity, biology and conservation*. West Sussex: Wiley. pp. 312–339.

Raby, G.D., Donaldson, M.R., Hinch, S.G., Patterson, D.A., Lotto, A.G., Robichaud, D. et al. (2012) Validation of reflex indicators for measuring vitality and predicting the delayed mortality of wild coho salmon bycatch released from fishing gears. *Journal of Applied Ecology.*, *49*(1), 90–98.

Raby, G.D., Packer, J.R., Danylchuk, A.J. & Cooke, S.J. (2014) The understudied and underappreciated role of predation in the mortality of fish released from fishing gears. *Fish and Fisheries.*, *15*(3), 489–505.

Stevenson, R.D. (1985) Body size and limits to the daily range of body temperature in terrestrial ectotherms. *The American Naturalist*, *125*(1), 102–117.

Winne, C.T., Ryan, T.J., Leiden, Y. & Dorcas, M.E. (2001) Evaporative water loss in two Natricine snakes, *Nerodia fasciata* and *Seminatrix pygaea*. *Journal of Herpetology*, *35*, 129–133.

How to cite this article: Forgues, N., LaRochelle, L., Burton, D. & Cooke, S. J. (2022). Effect of wind speed and light intensity on reflex impairment of angled Smallmouth Bass (*Micropterus dolomieu*). *Fisheries Management and Ecology*, *29*, 753–759. https://doi.org/10.1111/fme.12579