Backcountry use by recreational angling and non-angling parties in Algonquin Provincial Park (2015–2018)

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Cover photo: Krystal Mitchell portaging a canoe between Algonquin Provincial Park lakes. Credit: Nick Lacombe

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Abstract

Algonquin Provincial Park (APP) in southern Ontario, Canada, has been a destination for recreational anglers for over a century. In recent years, park visitor registration transitioned to an electronic system. All visitors who camped overnight in 2015 to 2018 registered their camping itinerary electronically. Upon arrival at an access point, registrants stated whether they intended to angle (yes/no) and, if yes, identified their target fish species. This approach yielded daily data about the number and distribution of backcountry camping parties. Ranking access points revealed that angling and non-angling parties accessed the backcountry via different routes. Based on data from all access points (2016–2018, inclusive), angling parties represented 35.3% of total backcountry party nights. Trip duration (number of nights spent camping) and the number of waterbodies visited were similar between angling and non-angling parties. Seasonal use patterns of APP backcountry were similar among years, with angling parties outnumbering non-angling parties in early spring — the only period when this occurred. Partitioning angling parties by target species helped assess seasonal backcountry use. Each year, trout anglers began using the APP backcountry before all other angling parties while backcountry use by anglers targeting bass and other species peaked in summer. Generalist anglers (no stated species preference) were the most frequent angling party type during summer. Non-angling party distribution among backcountry watersheds matched campsite distribution. Angling parties covered all watersheds in APP, but coverage varied with anglers' stated species preferences. Travel distance and elevation change (a form of cost) appeared to influence trade-offs of time allocation (travel vs. camping) within and among angling party types across the APP backcountry camp zones. In open-access recreational fisheries outside protected areas, backcountry angling may be more associated with concepts of place attachment vs. factors influencing angler motivation and movements. This study revealed key areas for further inquiry about APP backcountry angler motivation to support effective management of this popular open water recreational fishery.

Résumé

Utilisation de l'arrière-pays pour les séjours de pêche récréative ou sans pêche dans le parc provincial Algonquin (2015-2018)

Le parc provincial Algonquin (PPA), situé dans le sud de l'Ontario, au Canada, est une destination de pêche récréative depuis plus d'un siècle. Depuis quelques années, l'enregistrement des visiteurs du parc passe par un système électronique. De 2015 à 2018, tous les accès avec nuitée ont été enregistrés par voie électronique, incluant un itinéraire de camping précis. À leur arrivée à un point d'accès, les visiteurs indiquent s'ils ont l'intention de pêcher (oui/non) et, si oui, identifient l'espèce de poisson visée. Cette approche a permis d'obtenir des données quotidiennes sur le nombre et la répartition des groupes de campeurs dans l'arrière-pays. Le classement des points d'accès a révélé que les visiteurs accèdent à l'arrière-pays par différents points d'accès selon le but du séjour (avec ou sans pêche). D'après les données sur l'ensemble des points d'accès (2016 à 2018, inclusivement), les séjours de pêche représentaient 35,3 % du total des séjours dans l'arrière-pays. La durée du voyage (nombre de nuits passées à camper) et le nombre de plans d'eau visités étaient similaires entre

les visiteurs venus pêcher et les autres visiteurs. Les schémas saisonniers d'utilisation de l'arrière-pays du PPA étaient similaires d'une année à l'autre, avec des séjours de pêche récréative plus nombreux que des séjours sans pêche au début du printemps - la seule période où cela s'est produit. La répartition des séjours de pêche récréative par espèce visée a permis d'évaluer l'utilisation saisonnière de l'arrière-pays. Chaque année, les pêcheurs de truites ont visité l'arrière-pays du PPA avant tous les autres groupes de pêcheurs, tandis que la fréquentation de l'arrière-pays par les pêcheurs ciblant l'achigan et d'autres espèces atteint un sommet en été. Les pêcheurs généralistes (sans préférence d'espèce déclarée) constituent le type de groupe de pêcheurs le plus fréquent en été. La distribution des séjours sans pêche autour des bassins de l'arrière-pays correspondait à la distribution des sites de camping. Les séjours de pêche récréative s'étendaient sur tous les bassins du PPA, mais leur emplacement variait en fonction des espèces visées indiquées par les pêcheurs. La distance à parcourir et le changement d'altitude (une forme de coût) sont des critères concernant le partage du temps (entre le déplacement et le camping) qui semblent influencer les choix en matière de séjour au sein et entre les types de groupes de pêcheurs dans les zones de campement dans l'arrière-pays du PPA. Dans les pêcheries récréatives à accès libre en dehors des zones protégées, la pêche en arrière-pays est possiblement davantage associée à l'attachement à un lieu qu'à des facteurs influençant la motivation et les mouvements des pêcheurs. L'analyse de ces données a révélé des domaines clés à analyser dans le cadre d'une enquête plus approfondie sur la motivation des pêcheurs de l'arrière-pays du PPA qui nous permettra de soutenir une gestion efficace des populaires activités de pêche récréative en eau libre.

Acknowledgements

The authors thank the Algonquin Provincial Park visitors and anglers who participated in the Algonquin Park Angling Survey (APAS); the Ontario Parks staff and Algonquin Provincial Park permit office attendants who implemented the APAS; and Emily Cowie, Natasha Eastman, and Emily Hamilton for collecting and entering data. We also recognize the Algonquin Fisheries Assessment Unit staff who designed and implemented previous iterations of angler surveys and shared knowledge and information to improve this survey.

Contents

Introduction

Participants in backcountry recreation in remote locations or protected areas are immersed in the means of travel, natural features of routes and destinations, and survival in wilderness. This experience has been described as a relationship between participants and place leading to strong personal attachment (Brooks et al. 2006, Dvorak et al. 2013). In Canada, backcountry recreation often involves canoeing combined with portaging (i.e., hiking while carrying a canoe) between waterbodies. Recreational angling is one of several activities that can be part of a canoeing backcountry experience and is a common activity in some canoeing wilderness areas (Dvorak et al. 2012). The relative representation of anglers among backcountry visitors or parties is largely unknown because of challenges in covering all access points to backcountry landscapes, a challenge not unlike estimating angler distribution in recreational fisheries and other water-based recreation at broad scales (Venohr et al. 2018, Arlinghaus et al. 2019).

Backcountry anglers are also part of a spatial process widely recognized in recreational fisheries as a social-ecological system involving angler choices and movement in lake networks (Hunt et al. 2013, Arlinghaus et al. 2017, Carruthers et al. 2019, Solomon et al. 2020, Wilson et al. 2020). In open-access recreational fisheries, angler choices based on costs, regulations, and expected catch quality (species, fish size, catch rate and harvest limits) determine their distribution among lakes (Hunt et al. 2019a) and, potentially, the success of management models (Ward et al. 2016). Generally, however, information about landscape scale angler distribution is scarce, especially for multi-day trips that may involve very different motivation and satisfaction criteria than single day trips (Hunt 2008).

Management models for protected landscapes may be motivated by purposes broader than recreational fishing so present a more complex management regime than one based only on regulations as portrayed in open-access fisheries (Andrade and Rhodes 2012, Ward et al. 2016). In protected areas, management models can be focused on conservation as a broad priority, including prescribing human density (i.e., camp sites per lake) in areas based on aesthetics or ecological impact, in addition to fishing regulations. In Ontario, legislation behind parks and conservation reserves describes the maintenance of ecological integrity as the first priority for managing these landscapes, with ecological integrity defined under the *Provincial Parks and Conservation Reserves Act* (2006) as “a condition in which biotic and abiotic components of ecosystems and the composition and abundance of native species and biological communities are characteristic of their natural regions and rates of change and ecosystem processes are unimpeded”. Backcountry anglers in protected areas may prioritize features of catch quality related to the ecological integrity of food webs with native fish species vs. non-native species (Edwards et al. 2016). However, successful preservation of native fish communities maintains a limited diversity of target species available to anglers. While this approach can amplify some obvious management challenges by concentrating fishing activity on the few native species available, it could also elicit synchrony in angler activity as documented in other homogenous fisheries (Kaemingk et al. 2018), providing insights into angler site selection dynamics in protected areas.

Parks and protected areas offer distinct opportunities for person-place attachment by anglers, based on protected area priorities (e.g., conservation, limited access, species priorities). Besides targeting fish, backcountry anglers share experiences in remote or protected area landscapes with non-anglers where both may develop deep personal attachment to place (Budruck et al. 2008) and maintain safety and sustained social bonding by camping in parties, further enhancing person-place attachment (Nisa et al. 2020). The collective motivations and choices of anglers and non-anglers may therefore be similar to non-angling backcountry campers, including seeking low human densities and remoteness, disconnecting from society as leisure, and a natural environment defined by site quality and not solely catch quality. Place attachment may be encompassing in similar ways for all backcountry participants. As such, in managing protected areas, person-place relationships may be an important consideration as well as a fundamental conceptual difference from social-ecological perspectives of open-access recreational fisheries (Hunt 2008).

Because parks and protected areas often have a mandatory registration system for multi-day trips, limited access points, and designated camping locations, the possibility of conducting spatially explicit census-level fisheries surveys can be realized by linking camping itineraries to the canoe route network in a geographic information system (Drage et al. 2021). Comprehensive angler sample coverage may reveal underlying behavioural patterns in angler/non-angler distribution not previously detected through traditional fisheries monitoring techniques such as aerial angler counts, while avoiding biases related to timing of sampling (McCluskey and Lewison 2008).

The objective of this study was to determine the relative representation and distribution of backcountry angling parties within the larger community of backcountry visitors to Algonquin Provincial Park (APP), an iconic park in south-central Ontario. We examined data from an electronic camping registration system (hereafter, ECRS) that included questions asking parties to self-identify whether they would be angling and for those that were angling to identify target species groups. Using this data, the distribution of non-angling parties could be compared to that of angling parties with or without species group preferences. The ECRS database, therefore, provided near-census level insight into whether backcountry angling and non-angling parties (1) enter this protected area landscape from similar access points, (2) occupy watersheds in similar spatial patterns, (3) have similar trip characteristics such as duration and waterbody visitation rates, (4) have similar seasonal patterns of backcountry use, and (5) accept similar travel costs (i.e., travel distance and elevation change) and make subsequently similar time trade-offs in travel vs. camping. In several reviews, this scale of landscape coverage of angler distribution, including degree of angler type diversity, has been identified as a necessary element of recreational fisheries management (Arlinghaus et al. 2019, Brownscombe et al. 2019, Hunt et al. 2019a).

Methods

Algonquin Provincial Park (area =7,630 km^2) is in south-central Ontario and encompasses 802 lakes (>10 ha) and >3,700 km of rivers and streams in the headwaters of five secondary watersheds (Figure 1). The park has been a recreational fishing destination for over a century (Mitchell et al. 2017), and the aquatic ecosystems supporting this recreational fishery have been the focus of scientific study for nearly as long (Dymond 1964, Killan and Warecki 1998). The APP backcountry contains numerous natural brook trout and lake trout lakes representing two sought after target species for backcountry anglers. Splake (*Salvelinus namaycush x Salvelinus fontinalis*) and brook trout are stocked in lakes near main access corridors. Introduced populations of smallmouth bass (*Micropterus dolomieu*) and largemouth bass (*Micropterus salmoides*) occur in lakes along the Highway 60 corridor and in some backcountry lakes (Mitchell et al. 2017). Other species available for recreational fishing in the park include northern pike (*Esox lucius*) in the Opeongo River system surrounding the Shall Lake (#17) access point (Figure 1a) and upstream to the Lake Opeongo dam (Ridgway et al. 2017). Walleye (*Sander vitreus*) and muskellunge (*Esox masquinongy*) also occur in the Petawawa River drainage on the northeastern edge of the park. Angling represents a key aspect of the cultural identity of APP (Baker 2002).

Nine vehicle-access campgrounds and 404 backcountry camp zones (waterbodies with at least one campsite) are available to reserve on a first-come, first-serve basis via the ECRS. Reservations are accepted up to five months in advance of a party's arrival date and can be made online, via telephone, or in person. The ECRS captures the size (maximum of nine individuals per party) and planned itinerary of each party, including their access point of departure (Figure 1a,b) and the camping zones they intend to occupy for each night of their trip. Except for three hiking-only backcountry routes and two horse-packing routes, movement for backcountry camping parties in APP generally occurs among prescribed canoe routes and portage trails (i.e., hiking between lakes) in the river and lake network. Parties are required to use one of the prescribed campsites in the camp zone identified for each night of their itinerary. Itineraries in the ECRS do not include the exit access point for a given party on the last day of their backcountry trip.

Camping registration and the electronic database

Park visitors acquired their camping permit upon arrival to the park at offices in and around the park (Figure 1a,b). From 2015–2018, when backcountry camping parties obtained their permits, they also participated in the Algonquin Park Angler Survey (APAS). Permit office attendants asked parties a series of questions about their angling intentions and recorded responses in the ECRS. Parties were asked: *Will anyone in your party be fishing?* with response options of *Yes* or *No*. If yes, respondents were subsequently asked *What species will you be fishing for?* with response options of *trout*, *bass*, *other*, or *unsure*. In 2016, the survey was expanded to include vehicle-access campgrounds (Figure 1a,b). Campground visitors were asked the same questions as their backcountry counterparts. The question set addressed to angling parties was consistent through 2018. Combining this angling-specific data with that collected from all backcountry visitors allowed us to estimate the total overnight angler population utilizing APP.

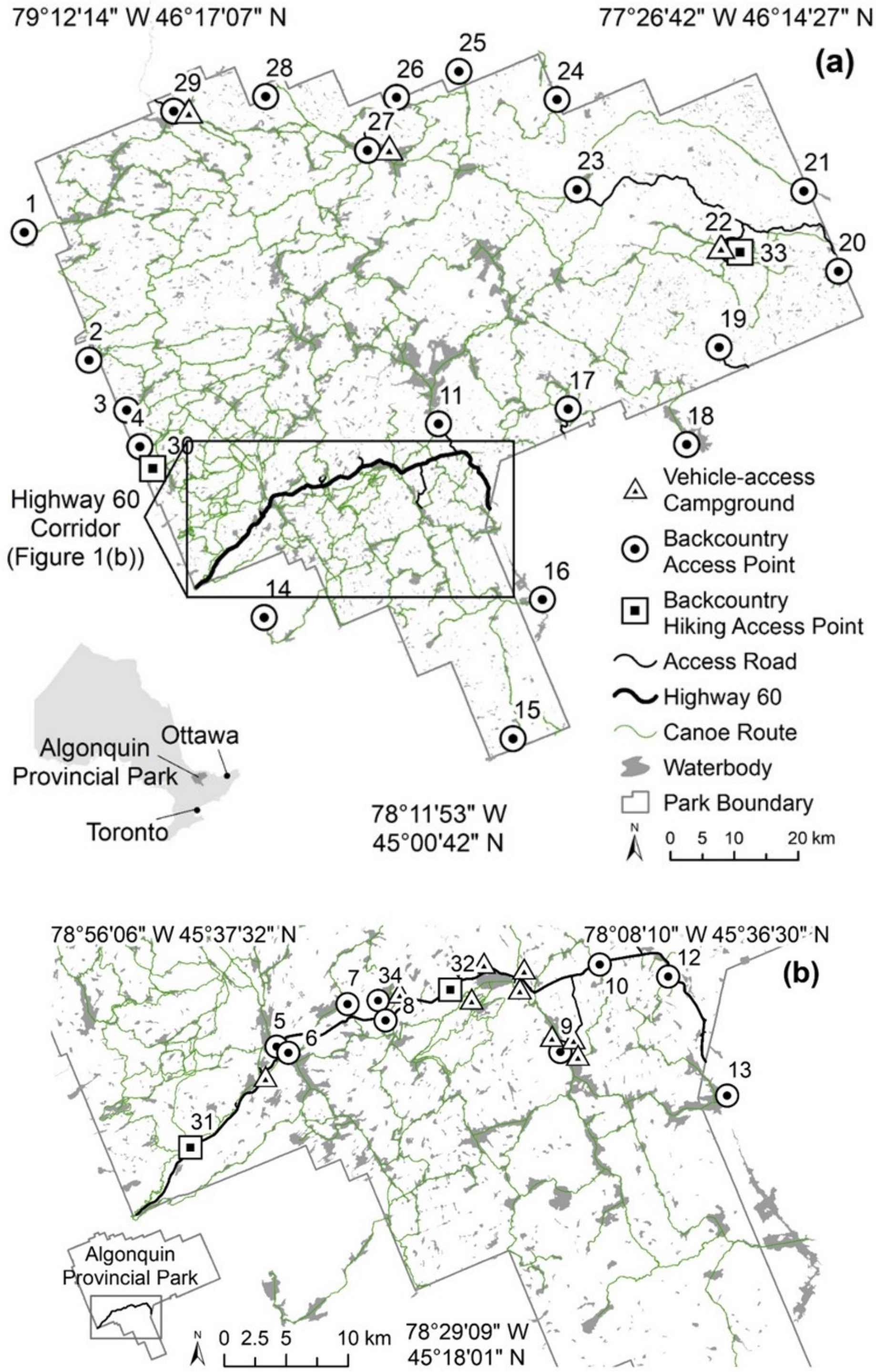

Figure 1. (a) Map of Algonquin Provincial Park showing backcountry access points and backcountry canoe routes among lakes. Inset map shows location of Algonquin Provincial Park in Ontario. (b): The main Highway 60 corridor with backcountry access points and vehicle-access campgrounds in Algonquin Provincial Park. Inset map shows Highway 60 location in Algonquin Provincial Park.

Four permit office locations recorded camping reservation data in hardcopy form throughout the duration of this study: Shall Lake (#17), Kingscote Lake (#15), Kawawaymog Lake (#1), and Brain Lake (#28) (Figure 1a). Reservation and angling information collected at these offices was not entered into the ECRS in 2015. This information was included from 2016–2018 when the data were entered into the database. Itineraries of backcountry parties recorded in the ECRS were assumed to have been completed as planned as no mechanism is in place to verify itineraries. Weather or overly ambitious planning may have caused some parties to alter their itineraries, but likely infrequently.

The ECRS database was examined for data quality and to identify parties with unique travel modes. About 3% (3,825) of parties were not classified by permit office staff as angling vs. non angling; 131 parties were omitted as they used the horse-packing trail to access a specific waterbody; 379 parties with itinerary errors were omitted; and 529 parties were omitted that were recorded with party sizes larger than the permitted maximum of nine. Once cleaned, the resulting data set used for this study consisted of records for 85,622 backcountry camping parties from 2015 through 2018, of which 55,504 were non-angling and 30,118 were angling parties. Backcountry hiking (backpacking, no canoeing) parties (N=11,425) were also included in data summaries but were excluded from spatial analysis and mapping given their exclusively land-based travel mode. At some access points (N=13) and interior waterbodies (N=21) in APP outboard motor use is permitted with specific horsepower restrictions. The use of canoes vs. outboard motors/boats was not documented in the ECRS. While canoes are the main mode of travel used in the APP backcountry, a small but unknown number of parties would have used boats and motors where and when permitted.

Similar data checks were performed on records for vehicle-access campgrounds when applicable. Campgrounds permit a maximum party size of six people, except for single families of parents and children that may total more than six. Campground parties recorded as having more than nine individuals not of the same family were omitted from the analysis (N=162 permits). Screening campground ECRS registrations resulted in 107,257 vehicle-access camping permits from 2016–2018, of which 94,798 were non-angling and 12,459 were angling parties.

Spatial distribution of camping itineraries

Backcountry camping trip itineraries were assigned spatial locations as follows. Each party’s itinerary for each night of camping was linked to a georeferenced camp zone representing waterbodies with at least one registered backcountry campsite. To calculate distances travelled and elevations traversed (i.e., *cost*) by backcountry parties, a georeferenced portage route system was imported into the Network Analyst extension in ArcGIS 10.3.1 (ESRI 2015) where distances and elevation change between all possible combinations of access points to camp zones and between camp zones were calculated as an origin-destination cost matrix and then matched to each camp zone origin-destination for each day for all party’s itineraries. The total trip distances and total elevation change are an underestimate of true distance and elevation change for each party’s itinerary because the backcountry exit access point is unknown. Thus, total trip distance does not include the distance travelled during the last day of the trip to exit the park.

While parties self-identified as angling or non-angling, not all members of an angling party were necessarily anglers. Additionally, individual effort (rod-hours) likely varied within angling parties. Thus, for this study, the unit of measurement for angling activity is party nights. Effort summaries are based on total party nights and daily time series of all camping parties in the backcountry represent a sum of all party nights per category (non-angling, angling, etc.) on the APP landscape for a given day.

Ontario anglers have a choice between purchasing an annual sport or conservation fishing license, with the latter costing slightly less. Type of license was not captured in the ECRS. With a sport license, the daily aggregate trout limit is five (lake trout, brook trout, and splake combined, of which a maximum of two may be lake trout), or species daily harvest limits of two lake trout per day, or five brook trout per day, or five splake per day. The aggregate bass (smallmouth bass and largemouth bass) sport license limit is six per day. With a conservation license, the daily harvest limit is two lake trout, two brook trout, two splake, or an aggregate of two trout per day (one lake trout and one of either brook trout or splake) and two bass per day.

In APP, trout fishing season begins on the fourth Saturday of April and ends on September 30th of each year. The last season day for splake angling is November 30th. Late ice cover in spring can delay access to the backcountry and, when it does, reservations are withheld until open-water access is available. Bass fishing season opens on the last Saturday of June and ends on November 30th of each year. Fourteen trout lakes have reduced daily catch or size restrictions in APP, of which eight have campsites. At the time of this survey, 48 lakes in APP were stocked (brook trout or splake with standard daily catch limits — sport: five, conservation: two), 17 of which had campsites.

Results

In this study, the annual total number of backcountry anglers ranged from 27,191 in 2017 to 28,022 in 2016 (Table 1). This total exceeded the number of anglers in vehicle-access campgrounds (11,439 in 2017; 16,285 in 2018). The total number of non-anglers (154,494 in 2018; 164,101 in 2015) exceeded the total number of all anglers combined (sum of backcountry, vehicle-access, and hiking route anglers ranged from 39,470 in 2017 to 44, 877 in 2018; Table 1).

Angling vs. non-angling party nights

Annually, total non-angling party nights in the APP backcountry exceeded angling party nights (2015–2018; Table 2). Angling party nights represented 30.8% of backcountry party nights in 2015 (data from four access points not recorded). From 2016–2018, when all access points were included, total angling party nights were consistent among years representing 35.7%, 35.2%, and 35.1% of all backcountry party nights for 2016, 2017, and 2018, respectively.

Table 1. Total number of people in parties self-identifying as angling and non-angling in vehicle-access campgrounds and the backcountry in Algonquin Provincial Park from 2015–2018. Backcountry visitors were partitioned into those using canoe routes vs. those using hiking routes. (NA=not available)

Activity	Main use	2015	2016	2017	2018
Angling	Vehicle-access campground	NA	13,774	11,439	16,285
	Backcountry canoe route	21,876	28,022	27,191	27,753
	Backcountry hiking route	621	900	840	839
Non-angling	Vehicle-access campground	NA	96,584	101,963	93,521
	Backcountry canoe route	46,404	53,804	56,330	55,197
	Backcountry hiking route	4,863	5,583	5,808	5,776

Table 2. Total annual number of backcountry party nights in Algonquin Provincial Park for park registrants self-identifying as angling or non-angling parties. Total party nights per year begins with the number of parties in the park on the first angling day and ends on September 30th, the end of the trout angling season. First angling day is either the last Saturday of April (trout opening day) or the availability of open water (i.e., no unsafe ice).

Year	Angling party nights	Non-angling party nights
2015	19,809	44,542
2016	24,826	44,698
2017	24,976	46,044
2018	25,052	46,385

Backcountry trip characteristics

Characteristics of backcountry trips were similar between angling and non-angling parties (Table 3). For all years combined (2015–2018), two-person camping parties were most common (38.3%, N=12,979 angling parties; 39%, N=25,903 non-angling parties). Solo anglers in the backcountry represented 7.4% (N=2,437) of all angling parties while 6.3% (N=4,204) of all non-angling parties were solo. The 50th and 75th percentiles ranged from three to four individuals for angling parties and three to five individuals for non-angling parties.

Total trip distance was also similar between backcountry angling and non-angling parties although non-angling parties generally travelled farther (mean=21.4 km) than angling parties (mean=18.8 km) (Table 3). Most angling parties travelled less than 43.2 km (90th percentile) and most non-angling parties travelled less than 50.9 km (90th percentile). The maximum distance travelled by a backcountry party was 265.6 km and 372.3 km for angling and non-angling parties, respectively.

Table 3. Summary of Algonquin Provincial Park backcountry angling and non-angling party trip duration (number of nights spent camping), number of waterbodies where camping occurred during backcountry trips, total distance travelled (km; portage trails + minimal distance paddling) for 2015–2018. Quartile range represents 25th to 75th percentiles. Summaries are based on cumulative distributions.

	Angling parties				**Non-angling parties**			
Trip info	**Median**	**Max**	**Quartile range**	**90th %**	**Median**	**Max**	**Quartile range**	**90th %**
Duration (nights camping)	3	21	2–4	5	2	21	2–3	4
Water-bodies used for camping	1	18	1–2	3	1	17	1–2	4
Total travel distance (km)	11.7	266	5.6–22.8	42.4	13.3	372	6.5–28.0	50.9

Most backcountry trips lasted five nights or less (90th percentile; Table 3). The tendency was for angling parties to remain a night longer (median=three nights) than non-angling parties (median=two nights). While in the backcountry, most angling and non-angling parties (90th percentile) camped on three (angling) or four (non-angling) waterbodies (Table 3). Fifty percent of both party types camped on one to two waterbodies (quartile range). The maximum number of waterbodies camped on was 18 for an angling party and 17 for a non-angling party.

Access point comparison of angling and non-angling parties

Angling and non-angling parties differed in how they entered the park (Figure 2). Lake Opeongo (#11) was the most used access point by anglers (Figure 2a) whereas Canoe Lake (#5) ranked first for non-anglers (Figure 2b). The mean number of non-angling parties using Canoe Lake access point per year from 2015–2018 (N=3,357) was more than double the mean annual non-angler use of the Lake Opeongo access point (N=1,497). Mean annual use of the Lake Opeongo access point was similar for angling (N=1,549) and non-angling parties (Figure 2a,b). In contrast, the ratio of mean annual non-angling to angling parties at Canoe Lake was 3:1 (non-angling parties N=3,357; angling parties N=1,136; Figure 2a,b). The third-ranked access point for non-angling parties was Grand Lake-Achray (#22) with a non-angling to angling party ratio higher than 6:1 (non-angling N=1,541; angling N=237; Figure 2a,b).

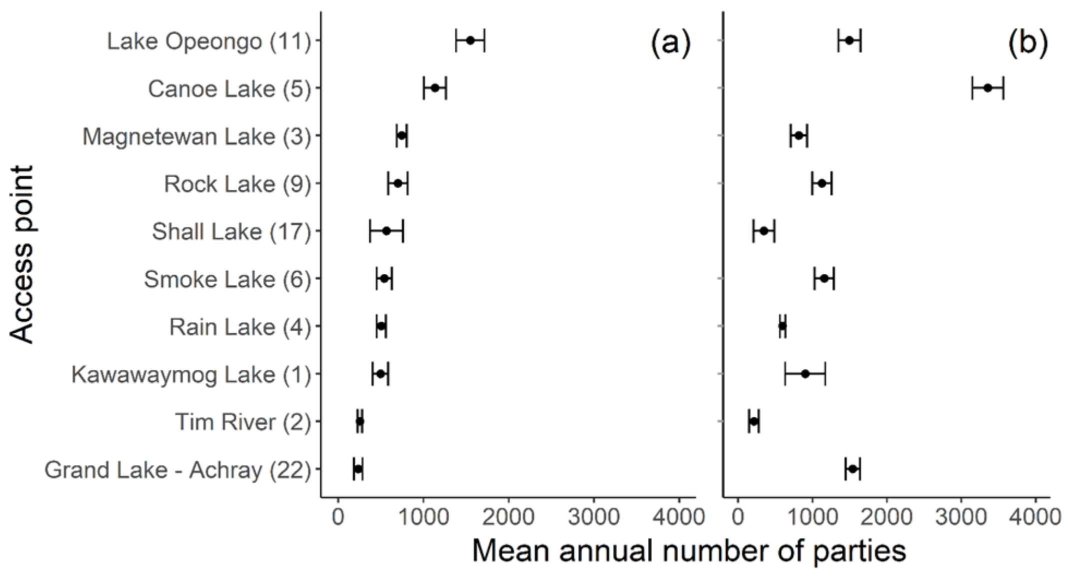

Figure 2. The top ten access points to Algonquin Provincial Park based on (a) use by angling parties and (b) the same access points based on use by non-angling parties. The mean number of parties (•) and range (horizontal line) for each access point for 2015–2018.

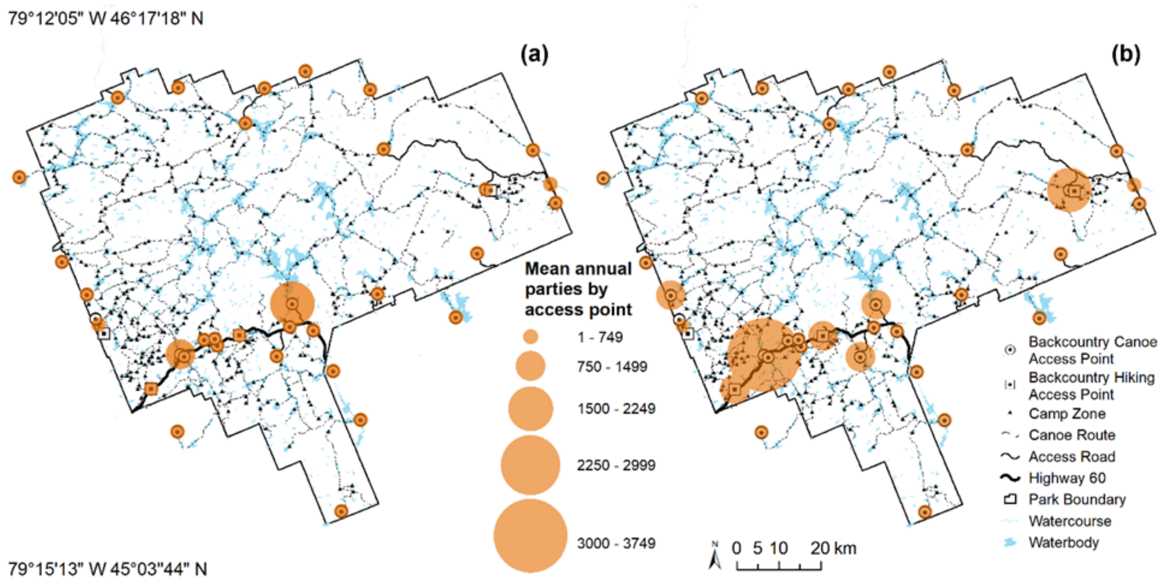

Figure 3. Mean annual party use of all access points to Algonquin Provincial Park for angling parties (a) and for non-angling parties (b), 2015–2018. Highway 60 is represented by the thick, dark, solid line. Canoe routes are dashed lines joining lakes.

The relative distribution of access point use for angling and non-angling parties was generally concentrated along the Highway 60 corridor (Figure 3). The Lake Opeongo (top ranked angler party access) access point is represented as the largest circle in Figure 3a. The Canoe Lake (top ranked non-angler party access) access is the largest circle in Figure 3b.

Based on target fish species as stated by angling parties, the top five access points present angling and non-angling parties with different challenges with respect to distance travelled and elevational change (m of elevation/100 m portage) (Figure 4). The total trip distance (km) and rate of elevation change (m of elevation change/100 m of portage) endured over the whole trip for parties at each of these access points was summarized as hexbin scatterplots. A hexbin is the tally of parties in each hexagonal cell of Figure 4. An empty hexbin means no parties had those combinations of distance and elevation change in their itinerary; these are not shown in Figure 4. More non-angling parties accept higher costs regardless of access point and subsequent route of travel through the backcountry. Both within and between the most popular access points of Lake Opeongo (#11) and Canoe Lake (#5), the stark trade-off between distance and rate of elevation change is demonstrated by all party types, with no parties taking on both large distances and high rates of elevation change in their routes.

Parties using the Canoe Lake access point face the greatest elevational change on portages, but fewer angling parties travelled long distances than did non-angling parties. A similar effect occurs at the Lake Opeongo access point but with less elevational challenge on portages. At the Magnetawan (#3), Rock (#9), and Shall Lake (#17) access points both party types travelled similar distances and faced similar elevational challenges. The travel distance at these three access points was more truncated than those at the Lake Opeongo and Canoe Lakes access points. This finding demonstrates differences among access points based on associated penetration range into the APP backcountry.

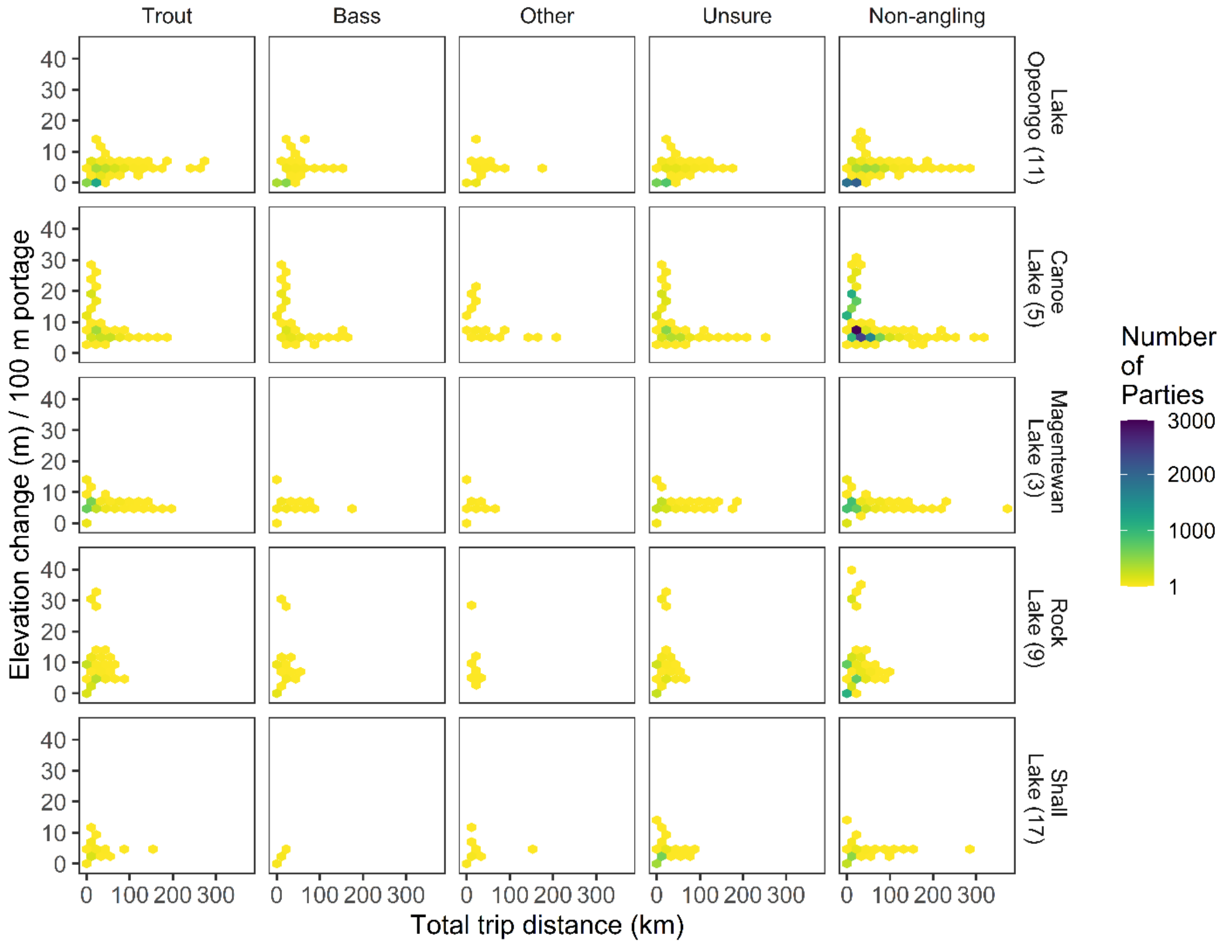

Figure 4. Hexbin scatterplot of backcountry party total trip distance (km) vs. trip cumulative elevation change (m) per 100 m portage by self-identified target species for the top five angler party visitation access points in Algonquin Provincial Park (2015–2018 combined).

Spatial distribution of angling and non-angling parties

The spatial distribution of non-angling parties across the APP backcountry suggests a strong relationship with the presence and availability of campsites in the canoe route network (Figure 1; Figure 5a). Designated campsite density (campsites per watershed) is not consistent across the park, fluctuating at the fourth order watershed level (Figure 5a). For non-angling parties, mean annual party intensity (party nights/watershed) aligned with campsite density across the park (Figure 5b). This alignment shows that the spatial distribution by non-angling parties in APP is a function of campsite numbers at watershed scale.

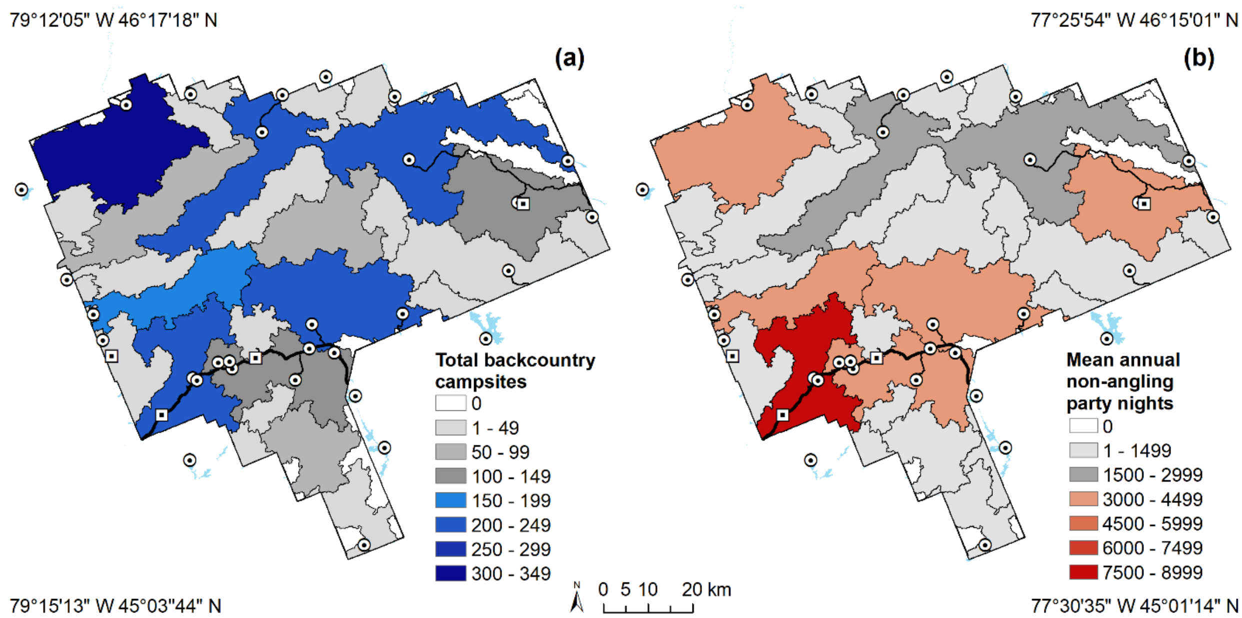

Figure 5. Backcountry distribution of non-angling parties at fourth order watershed scale: (a) the distribution of campsites per watershed available to backcountry visitors and (b) the distribution of backcountry use (mean annual party nights) by non-angling parties, 2015–2018.

The spatial distribution of angling parties presents a different landscape perspective in APP when partitioned by stated species preferences (trout, bass, other, or unsure) (Figure 6). Generally, angling parties were distributed among almost all watersheds in APP (light gray designation in each map). When partitioned, trout angling parties tended to match the distribution of campsites per watershed (Figure 6). This observation aligns with the broad distribution of lake trout and brook trout populations throughout APP. In contrast, bass angling parties tended to occupy watersheds near the main roads or historical railroads in APP where lakes were stocked with smallmouth bass over a century ago. Interestingly, parties stating bass angling preferences often travelled into the interior of APP where few bass populations occur. Whether these parties are searching for bass populations or are knowingly incorporating waterbodies without bass into their routes cannot be determined from the ECRS database. Whatever the basis of this choice, bass angling parties are widely covering APP watersheds occupied by lake trout and brook trout populations. Angling parties targeting *other* fish occupied all APP watersheds without any apparent concentration of activity (<299 annual angling party nights) at watershed scale. These parties may represent a more generalist angler type, given their relatively homogenous distribution and lack of association with a target species.

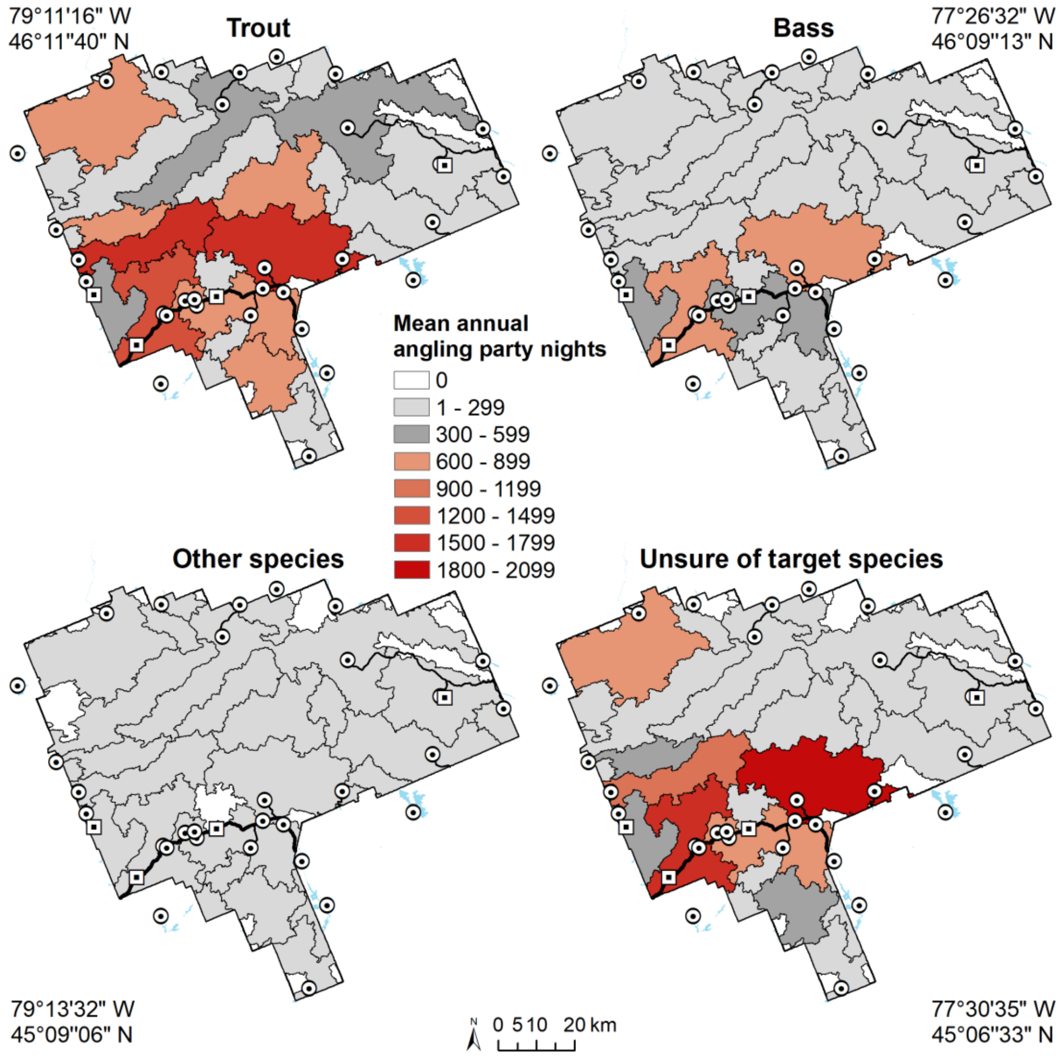

Figure 6. Backcountry distribution (mean annual party nights) by angling parties at fourth order watershed scale based on self-identified target species: trout (top left), bass (top right), other species (bottom left), and unsure of target species (bottom right), 2015–2018.

Angling parties with a stated preference of *unsure* also widely occupy APP watersheds (Figure 6). Their distribution reflects elements of bass angling parties in their concentration around the main Highway 60 corridor while incorporating some of the broader distribution of trout angling parties into the interior of APP. However, unsure parties did not match the watershed scale campsite distribution in Figure 3a that trout angling parties tended to reflect. The unsure parties were most prolific in watersheds where both trout and bass fisheries exist, which may facilitate optimization of available species opportunities, conducive to a generalized angling objective.

Daily time series of angling and non-angling parties

Holiday weekends were used to partition each time series into periods (Table 4).

Table 4. Holiday weekend designations for the daily time series of party counts for angling and non-angling parties. The end of trout season (E) is not a holiday weekend.

Holiday weekend	Designation
May; Victoria Day	A
July; Canada Day	B
August, Civic Holiday	C
September, Labour Day	D
September 30, last day of trout season	E

The daily pattern of backcountry use by angling and non-angling parties for each of the four years (2015–2018) revealed consistent seasonal activity (Figure 7). Weekends (Friday and Saturday; and Sunday for holiday weekends) throughout each fishing season stand out as regular peaks in visitation to APP separated by weekdays (Monday to Thursday). Each year, weekends represented nearly 50% of all angling activity in the backcountry; 49.7%, 48.6%, 48.3%, and 48.6% in 2015, 2016, 2017, and 2018, respectively. Weekends represented 36–38% of total fishing season days from 2015–2018.

Holiday weekends consistently appear as peaks in APP backcountry use by both angling and non-angling parties (Figure 7). Angling parties outnumbered non-angling parties in early spring of each year, representing 59.9% of total backcountry parties for all years combined. Following the early spring period, non-angling parties consistently outnumbered angling parties each year. The increase in all backcountry parties after Canada Day weekend (B) is likely attributed to the end of primary and secondary school years and the start of summer holidays. Summer, defined as Canada Day (B) through Labour Day (D), represented the highest number of backcountry parties in APP with non-angling parties (69.7%) exceeding angling parties (26.9%) (Figure 7).

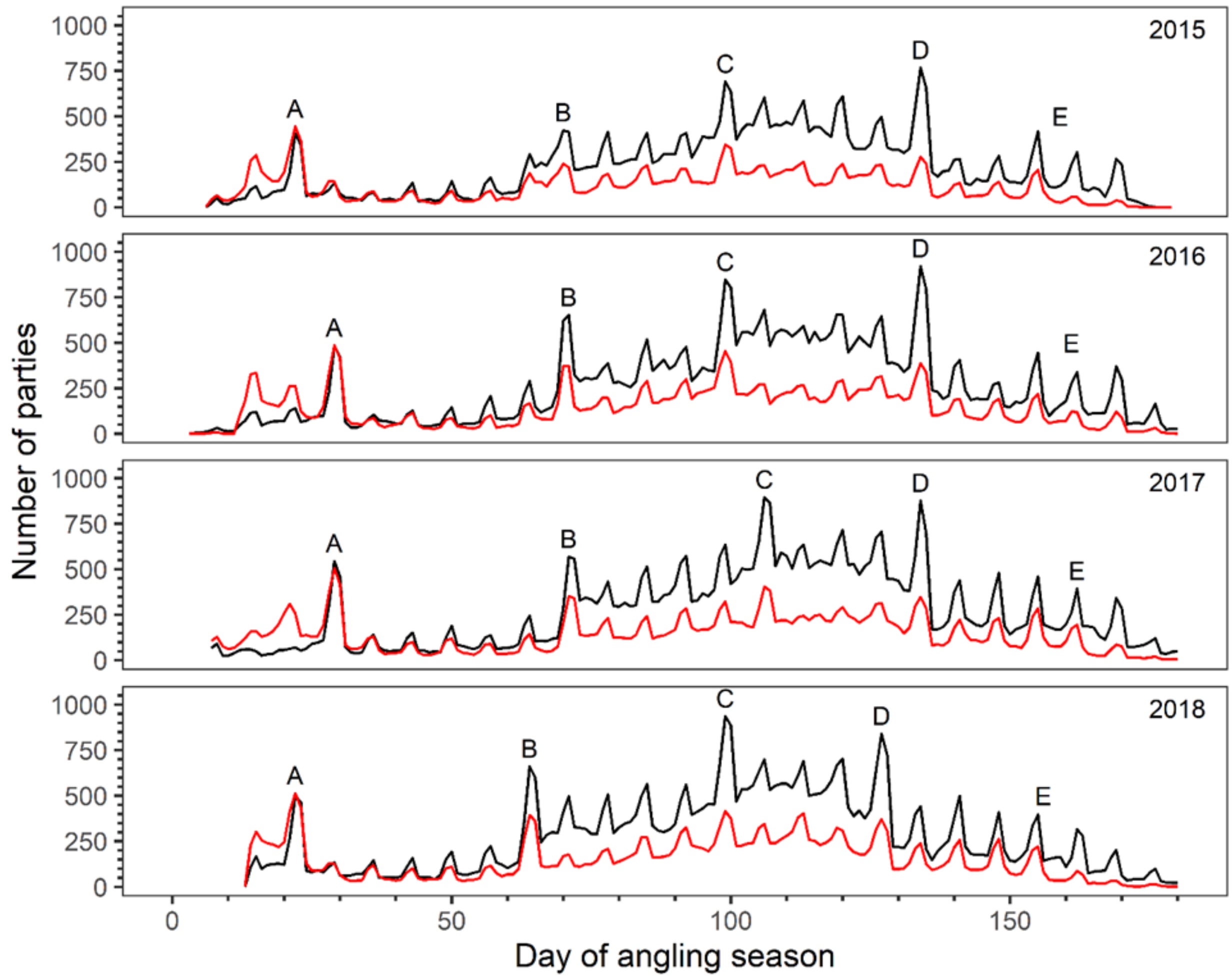

Figure 7. Annual time series of total daily number of backcountry parties in Algonquin Provincial Park (2015–2018). Each *day of angling season* is interpreted as a party night. For each year, non-angling (black) and angling (red) party nights begin on the first day of the angling season based on the official start of the trout season (fourth Saturday of April or the availability of open water). Holiday weekends representing three-day weekends are lettered A through D (see Table 4 for description). The last day of trout season is indicated (E; September 30). Weekend days were Friday and Saturday of each week plus Sunday for holiday weekends.

In all years, backcountry visitation lows occurred during each late spring period for all party types (after Victoria Day weekend (A) and before Canada Day (B); Figure 7). Lake stratification normally begins during this period so access to cold water fish species such as lake trout and brook trout in relatively shallow waters remains possible. By Canada Day weekend (B), ambient air temperatures are approaching annual highs and yet visitation barely exceeds that of Victoria Day weekend (A), over a month prior. We interpret this low period in each year as the *simulid season* when blackflies (family Simulidae) have fully emerged and are searching for blood meals for egg production. Canada Day weekend (B) appears to signify a transition to increased visitation, likely due to a combination of the start of summer holidays and end of the simulid season.

Partitioning the time series of angling parties into stated preferences (trout, bass, other, unsure) revealed additional seasonality within the overall angling group (Figure 8). In each year, the number of trout angling parties peaked in spring — trout angling season start through Canada Day weekend (A) — and declined to lower but consistent numbers for the balance of the angling season. The small number of trout angling parties after the season-end date of September 30th (E) are likely explained by those targeting splake, which has an extended fishing season. The seasonal occurrence of bass angling parties matched the opening day of bass season before Canada Day weekend (B). The number of angling parties not targeting trout or bass (i.e., other) was low relative to other angling preference types and remained low throughout the season in each year.

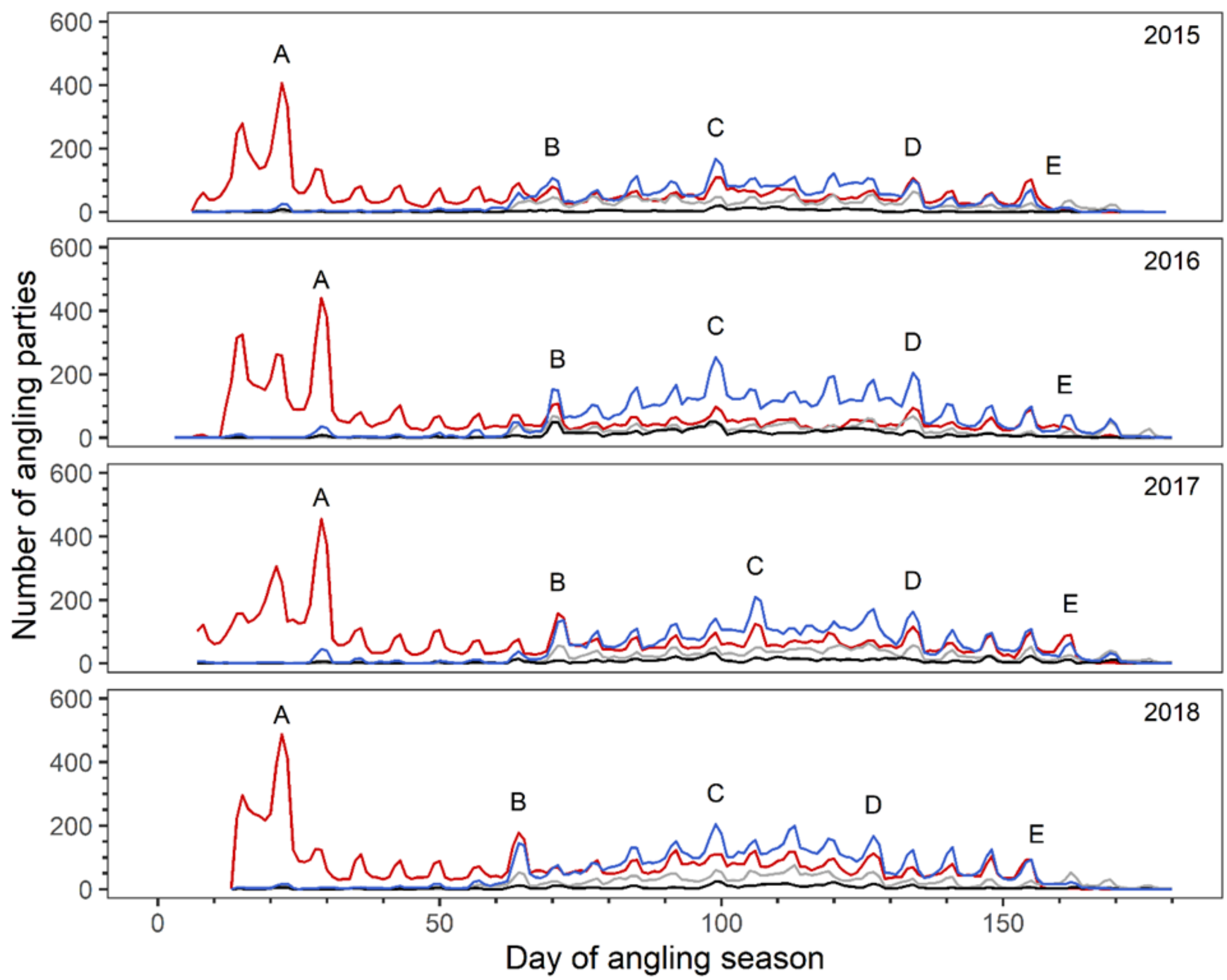

Figure 8. Annual time series of total daily number of backcountry angling parties in Algonquin Provincial Park (2015–2018). Each *day of angling season* is interpreted as an angling party night. For each year, trout (red), bass (gray), other species (black), and unsure of target species (blue) angling party nights begins on the first day of the angling season based on the official start of the trout season (fourth Saturday of April or availability of open water). See Table 4 for description of holiday weekends (A through D). The end of trout season is September 30 (E).

The most frequent angling party type in the summer period, from Canada Day (B) until Labour Day (D), was generalist angling parties or those without a stated preference (i.e., unsure). During this period, generalist angling parties represented 47.9% of all angling parties (all years combined, N=56,626 total angling parties). Trout angling parties represented 29.6% of all angling parties while bass and other angling parties represented 16.8% and 5.7% of all angling parties, respectively.

Time allocation to travel and camping in the backcountry

A given day in a trip itinerary can be viewed as travel or camping days and each day spent travelling or camping can be cumulatively tracked for the duration of a trip. The ratio of time invested in travelling to a camp zone vs. staying at the camp zone indicates how a total trip in each itinerary can be divided between these activities. This ratio is referred to as the time allocation ratio, which can be stratified by party type and expressed spatially by camp zone. The ratio of days to arrival at the camp zone vs. days of camp zone duration represents this trade-off by backcountry users. A ratio of 1.0 means the travel days until camp zone arrival is the same as days of camp zone duration. Ratios <1.0 represent relatively shorter travel time relative to duration of stay at the camp zone whereas ratios >1.0 represent longer travel time relative to total camp zone duration. Over the entirety of each party's trip, a time allocation ratio was obtained and summarized by party type (Figure 9). Non-angling parties had the highest median time allocation ratio (1.73) among party types and both bass and other target species angling parties had the lowest median time allocation ratio (1.33). Among angling party types, the parties unsure of target species had the highest median time allocation ratio of 1.59. Other target species parties had the lowest lower quartile time allocation ratio at 0.70.

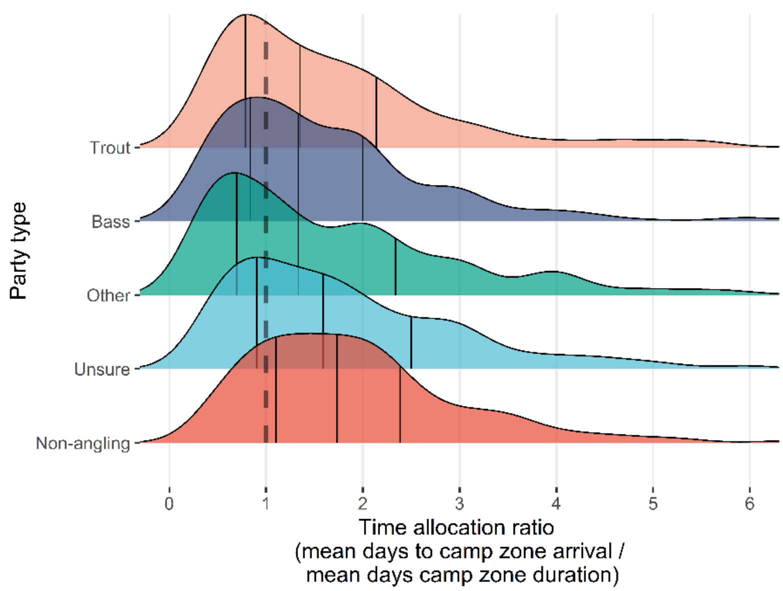

Figure 9. The distribution of time allocation ratio (mean days to camp zone arrival/mean days camp zone duration) by party type in Algonquin Provincial Park backcountry for 2015–2018. Median and upper and lower quartiles (solid black vertical lines) and 1:1 time allocation ratio (dashed black line) are included for reference.

Over the four years of this study, each camp zone's mean time allocation ratio can also be stratified by party type to provide spatial context on time investment variability among party types (Figure 10). Party types exhibit considerable variability in days to camp zone arrival across the APP backcountry. Several core interior areas consistently have the greatest travel times among party types (as indicated by the orange-red colour gradient in figure). Most areas of the backcountry near an access point have shorter travel times, which was consistent among party types (as indicated by the green colour gradient in figure). In general, trout parties had the longest trip durations to reach the interior, presumably due to slower travel speeds or increased time dedicated to angling.

Mean camp zone duration is generally limited to one or two days (Figure 10). Notably, mean camp zone duration appears to be consistently shortest for non-angling parties across the backcountry. The core interior camp zones of the backcountry revealed one distinct difference among party types where trout parties appear to have longer mean camp zone durations (consistently approximating 2 days) than all other party types overall (ranging variably by target species between 1 and 2 days). Another distinct spatial pattern emerges from the other target species angling party type in the camp zones accessible via the Shall Lake access point (access point 17 in Figure 1a) where mean camp zone duration ranges between three and four days. This area aligns with the distribution of recently invaded northern pike.

Patterns in the time allocation ratio vary within and among party types in the core interior areas of APP backcountry. In contrast, camp zone areas near the highway 60 corridor, and some other primary access points, had consistently low time allocation ratios across party types (Figure 10). These areas also align with the most popular access points (Figure 2) and most intensively used camp zone areas (figures 5 and 6). Broader areas of greater time allocation ratios (>2) in the APP interior are evident among non-angling and other target species party types as compared to trout, bass, and unsure of target species party types. Large areas of the APP backcountry require considerable travel time investment to reach and limited time investment in visitation due to their remoteness and the high costs for arrival and return.

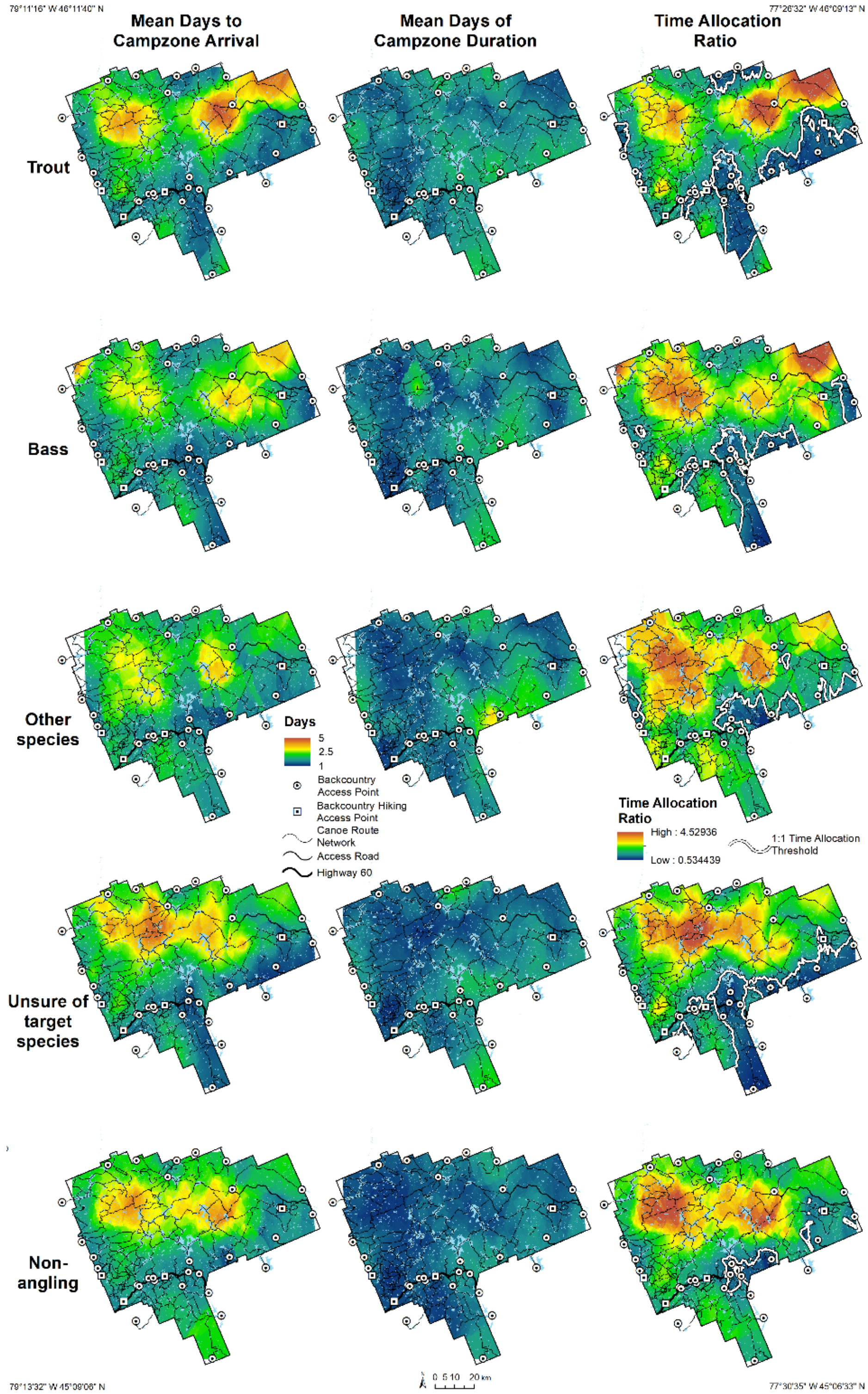

Figure 10. Mean days to backcountry camp zone arrival, means days of backcountry camp zone duration, and time allocation ratio (mean days to camp zone arrival/mean days of camp zone duration) by party type in the Algonquin Provincial Park backcountry for 2015–2018. Interpolation was Kriging based on ArcGIS defaults (12 nearest points) in ArcGIS 10.3.1.

Discussion

Annual and seasonal backcountry use by angling and non-angling parties in Algonquin Provincial Park revealed remarkable consistency in relative representation. Non-angling parties were more frequent in the backcountry in each year than angling parties. Backcountry use also revealed basic differences between the angling and non-angling party types in entrance to the backcountry landscape (Figure 2; Figure 3) and relative distribution among watersheds. For non-angling parties, distribution among watersheds reflected campsite density (campsites per watershed; Figure 5a). Angling parties of all types were broadly distributed among APP watersheds, but patterns of use differed based on stated preferences for fish species vs. unsure.

Differences in seasonal timing of park use by angling and non-angling parties were clear and repeated. Angling party visitation peaked in early spring and was lower than non-angling parties in summer and fall. Non-angling party visitation peaked in summer. The lowest levels of backcountry use by both angling and non-angling parties occurred in June coincident with the emergence of biting insects. Trout angling party visitation peaked in spring and was lower and consistent in frequency for the balance of the angling season (Figure 8). Trout angling parties tended to match the distribution of campsites per watershed, a feature shared with non-angling parties. Bass angling parties occupied watersheds closest to the main access road in APP but were also widely distributed in APP including in watersheds where bass are not present. Generalist angling parties, or those unsure of their target species, peaked in frequency in summer representing most angling parties at that time. Their distribution in APP appeared to be a combination of bass anglers in the occupancy of watersheds close to the access road but also more distributed as trout angling parties.

While these differences emerged at the landscape scale, trip characteristics were similar between angling and non-angling parties. Most trip durations were five days or less with the median trip being three days for angling and two days for non-angling parties. Quartile ranges indicated that angling parties were in the backcountry for two to four days and non-angling parties for one to three days. The number of waterbodies visited by most angling parties was three or less (90th percentile; Table 3) and for non-angling parties it was four or less (90th percentile; Table 3). Total travel distance compared between party types showed extensive overlap in distributions with non-angling parties tending to travel farther by small margins relative to angling parties. Certainly, at departure points at the start of backcountry trips, the equipment used by angling and non-angling parties appears similar in many aspects except for the presence of angling gear for one party type. Similar motivations for serious leisure exist among all backcountry party types (Brooks et al. 2006, Jun et al. 2012) while differences appear to lie in trip characteristics and waterbody network/destination dichotomies. Questions related to angler and non-angler motivations for their destination or their journey need to be explored and addressed through interviews.

The APAS survey is based on registration information for park access. The use patterns summarized in this study assume trips were completed as indicated through registration. Detours to other waterbodies en route or day trip use of waterbodies from base camp locations identified in party itineraries is a possibility and based on discussions with anglers is known to occur. Further exploration of backcountry uses and incorporation of other waterbodies into trips will require interviews upon trip completion or angler diary programs to evaluate the extent of variation in registered trips. As well, gathering voluntary information on angler avidity, prior experience in APP and frequency of use, and fidelity to trout or bass as target species would provide more insight into angler motivations and angler type (Beardmore et al. 2011, Hunt 2008), while concurrently incorporating angler participation in future fisheries surveys (Crandall et al. 2018).

Despite the limitations of the ECRS, differences in patterns of entrance to the APP landscape (Figure 2) and the subsequent travel costs endured (Figure 4), distribution among watersheds (figures 5 and 6), seasonal use (figures 7 and 8), and allocation of time travelling vs. camping (figures 9 and 10) provide relevant insights into backcountry visitor behaviour. Both angling and non-angling parties appear to agree on avoiding backcountry use in late spring when simulids are active. Cold, unstratified lakes in early spring appear to be a key consideration for trout angling parties each year given the relatively high use patterns. The degree of repeatability in seasonal and annual representation of angling and non-angling parties in APP suggests a deeper element in the motivations of both groups. Traditions of individual parties, whether targeting fish or not, may help dictate timing and frequency of use. *Spring fishing trips* or *summer canoe trips* are phrases often used by individuals to summarize their APP experience. Within both angling and non-angling parties, the high degree of temporal synchrony in the APP backcountry appears to be a result of cultural norms (i.e., long weekend vacations) consistent across all user groups. However, the repeated seasonal synchrony of angler party types across years supports the observations by Kaemingk et al. (2018) of angler synchrony within homogenous fisheries that offer a narrow diversity of target species and subsequently limited number of angler types. Complete trip interviews could be used to determine the degree of individual/party repeatability in backcountry routes and destinations within angling and non-angling parties.

Non-angling parties often complete a loop route in APP, beginning and ending at the same access point but not re-visiting the same lakes during the same trip (Figure 1). The occurrence of loop routes may account for the tendency of non-angling parties to travel a little farther and incorporate more lakes than angling parties. The loop approach may also account for non-angling parties matching campsite density across the park. For angling parties, the loop element of a backcountry trip may be defined by targeting lakes based on past angling success (Hunt 2005). Additionally, some angling parties are known to employ a base camp strategy whereby their documented itinerary is more linear, and often out and back, including day trips to adjacent lakes that would not be documented through the ECRS. This approach, in turn, limits the number of unique lakes documented in a trip itinerary. Therefore, the itineraries represent the generalized movement of angling parties across the landscape. The consistent focus of angling parties to a limited number of sub-watersheds suggests some level of site fidelity, which is associated with highly specialized anglers (Dabrowska et al. 2017). Further, the combination of both seasonal (gear-related) repeatability with limited spatial selectivity may constitute the *technique-setting specialists* end of the angler specialization continuum as suggested by Bryan (1977). The definition of trip satisfaction for anglers may be contingent on lake destination, whereas non-anglers may define trip satisfaction in terms of a lake network journey. The possibility of journey vs. destination motivations would be an interesting aspect of backcountry use for further research.

The perception of crowding is subjective but can influence visitor experience (Manning 1999) as well as angler experience and angling site selection (Hunt 2005, Arlinghaus et al. 2014, Matsumura et al. 2019, Birdsong et al. 2021). Further, place identity and place attachment may not alleviate the sense of crowding for anglers or non-anglers (Budruck et al. 2008). The influence of sense of crowding on lake selection by angling parties in the backcountry is mediated by the finite number of campsites available (Figure 3a). In landscapes outside APP, and in the absence of finite campsites, crowding effects for anglers are likely different and perhaps greater based on (a) the more liberalized angling regulations (e.g., a permitted winter fishing season for trout, use of live bait) (Ward et al. 2016), (b) a highly developed road network with boat launches (Kaufman et al. 2009, Hunt et al. 2019b), and (c) proximity to urban centres (Hunt et al. 2011, Post and Parkinson 2012, Wilson et al. 2020). Indeed, most visitors to APP, of which anglers represent a considerable portion (Table 1), are known to travel from hundreds of kilometres away (Eagles et al. 2015).

It appears that angling parties regularly use easily accessible backcountry sites with consistently high levels of campsite occupancy, particularly on holiday weekends (Figure 6; Figure 7). This observation suggests angling parties are satisfied with this level of activity in easily accessible backcountry sites. The sense of satisfaction and achievement obtained upon completion of a backcountry trip, regardless of travel costs invested or proximity to access sites, points to the importance of place identity and place attachment for APP backcountry users. The consistency in annual occupancy patterns on the APP landscape must be part of the backcountry culture for all backcountry users. Interviews on motivations of anglers and campsite selection would provide insight into choices, experiences, and satisfaction by angling and non-angling parties in backcountry site selection (Dvorak and Brooks 2013, Blahna et al. 2020).

Asking angling parties to self-identify based on target species also demonstrated the variability within a given angling party type in terms of time allocation. Some parties maximized camp zone duration and subsequently had more time for other activities (i.e., angling), while other parties were more focused on maximizing spatial coverage (i.e., exploration) in their trip resulting in a higher travel cost. The dichotomy between angling and other activities vs. exploration was true amongst all party types (Figure 10). This variability within angling party types may also reflect angler specialization/generalization where additional factors such as remoteness or localized physical landscape aesthetics beyond fishing success may not be weighted equally by parties of the same target species (Dabrowska et al. 2017). Further analysis at camp zone (waterbody and adjacent waters) scale for fishery-specific inferences along with angler interviews about site selection motivation is needed to help understand this time allocation variability within angling party types.

Camp zone time allocation ratios across the APP landscape revealed differences in the balance of time investment between travel and camping days across party types. The areas of highest variability in time allocation ratio among angling party types appeared to be camp zones of moderate travel cost investment and remoteness. These areas lie between the low-cost areas near access points and the high-cost deep interior, with general agreement across party types in both extremes (Figure 10). Further interviews with parties visiting the moderate cost camp zones would help capture angler motivation and specialization among party types and how this covaries with fishery dependant and independent indicators (Beardmore et al. 2011).

This study demonstrates the utility of a reservation system (i.e., ECRS) in combination with a simple angler survey (i.e., APAS) to provide landscape and daily insight into angler distribution and timing. This level of detail may also be available for other protected areas with limited access and a user registration system. Acquiring this kind of information about angler populations is a stated need (e.g., see Arlinghaus et al. 2019, Brownscombe et al. 2019, Hunt et al. 2019a) and an ever-present monitoring challenge for open-access recreational fisheries (Jones and Pollock 2013).

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Appendix 1. Happy anglers

Figure A.1. Happy lake trout anglers in the backcountry of Algonquin Provincial Park.

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