CHAPTER 5

Diversity of Anglers: Drivers and Implications for Fisheries Management

Len M. Hunt, Robert Arlinghaus, David Scott, and Gerard Kyle

5.1 INTRODUCTION

Fishing for recreation dates back at least 4,000 years ago when the first images of recreational anglers were reported from Egypt (Pitcher and Hollingworth 2002). It was widespread in Europe by the 13th century and has substantially grown with industrialization across the world (FAO 2012; see Pitcher and Hollingworth 2002 for more historic details). The English publication *Treatyse of Fysshynge wyth an Angle* (attributed to Berners [2018]) describes the activity of recreational fishing with hook, rod, and line and the diversity of fishing styles that were tailored to catch different fish species in different settings. Later, Walton and Cotton (1935) described the spiritual and deeply leisure-based aspects of recreational fishing. Recreational fishing is now pursued in most countries, except maybe the poorest (FAO 2012; Arlinghaus et al. 2015), in part because of increasing wealth and leisure time (Smith 1986) as well as advances in information and technology that facilitate (1) access to fishing sites (e.g., boats, passenger vehicles, snowmobiles, Global Positioning System devices), (2) the finding of vulnerable fish (e.g., sonar, downriggers), and (3) the capture of fish (e.g., artificial fishing lures and hooks). The ingenuity of people, combined with traditions and customs, has resulted in a rich mosaic of recreational fisheries that are characterized by diverse fishers and fishing styles that encompass the continuum from harvest-dominated to voluntary catch and release and from fishing with a pole in a local pond to offshore fishing for billfish in the open ocean.

Angling is a specific method of fishing involving the use of a hook and line that is closely attended by an individual to capture aquatic species. Angling represents the most common capture method of fish by recreational fishers (Arlinghaus and Cooke 2009). Consequently, we use the term "angling" synonymously with "recreational fishing" in this chapter, acknowledging that in some areas of the world, such as Scandinavia, recreational fishing is conducted with gill nets, traps, and many other typically commercial gear. Similarly, in North America some fish are harvested with bows, while recreational spearfishing is common around the world. We also note that in many areas of the world, people use angling methods for commercial and subsistence purposes. Given the focus of the book and the fact that "angling" is a typical umbrella term for modern recreational fisheries, we use the term "angling" here for convenience.

This chapter focuses on the diversity inherent in recreational fisheries. Diversity is used to describe how heterogeneous landscapes, anglers, and/or other contexts shape anglers' behaviors. Diversity greatly complicates the identification of appropriate and optimal management solutions for recreational fisheries (e.g., Johnston et al. 2010; Fenichel and Abbott 2014). Angler

diversity (also termed "heterogeneity") has been a frequent topic in the human dimensions of recreational fisheries since the late 1970s (e.g., Bryan 1977; Chipman and Helfrich 1988). In fact, research on angler diversity continues to be largely parochial with many researchers using a single way to characterize (e.g., Graefe and Ditton 1986; Hutt and Neal 2010) or to account for (e.g., Train 1998; Breffle et al. 2011) angler diversity. Little uptake has occurred by fisheries biologists and managers of appropriate methods to measure angler diversity.

The purpose of this chapter is to identify drivers of angler diversity, describe the consequences of angler diversity, and suggest how diversity might shape future angling and recreational fisheries. This emphasis on angler diversity is consistent with recent calls from human dimensions (e.g., Hunt et al. 2013) and fisheries ecology (e.g., Post 2013) researchers about the overwhelming importance of angler diversity in recreational fisheries (Arlinghaus et al. 2017).

In the next section, we focus on why diversity matters for a range of issues, such as overharvest and the benefits that anglers receive from fishing. The following section identifies contextual and individual drivers of angler diversity. In the fourth section, we describe existing conceptualizations used to typify diversity by anglers' commitment (often referred to as specialization in the human dimension studies; Bryan 1977) or the personal relevance of the activity. The final section is purposefully speculative with a focus on the future of angling and concluding remarks about the opportunities and challenges of angler diversity.

5.2 WHY DOES ANGLER DIVERSITY MATTER?

An angler serves a dual role of a stressor who impacts recreational fishing resources and a receiver who benefits from fishing (right side of Figure 5.1). We begin by briefly describing some impacts and benefits associated with diversity. We then identify key traits of anglers that clearly influence anglers' behaviors and associated outcomes to recreational fisheries. The keen reader is referred to more comprehensive reviews and discussions (Post et al. 2002; Lewin et al. 2006; Arlinghaus et al. 2007, 2017; Hunt et al. 2013; Ward et al. 2016).

5.2.1 Angling Impacts on Fisheries Resources and Aquatic Ecosystems

Anglers directly affect fish and aquatic ecosystems through harvesting fish, catching and releasing fish, and using gear, equipment, and bait to find and catch fish, as well as nonlethal wildlife disturbance (Lewin et al. 2006). The harvest of fish by anglers and unwanted hooking injuries and stress result in fishing mortality that, in turn, depends on the amount of fishing effort that anglers expend, the skill of anglers at catching fish, and the size and resilience of the fish stock (Johnston et al. 2010, 2013; Ward et al. 2013). Consequently, both changes to the amount of fishing effort and the skill of anglers can affect fishing mortality (Ward et al. 2013). Fishing mortality that exceeds natural mortality can result in overexploited stocks, including size overfishing due to size and age truncation (Radomski et al. 2001), that may be invisible to fisheries managers due to poor monitoring (Post et al. 2002).

Even when anglers release caught fish, lethal and sublethal effects can occur (e.g., Bartholomew and Bo^{h}nsack 2005; Arlinghaus et al. 2007). The level of effect depends on the fish species, environmental context, and actions taken by the angler. For example, in a review of studies on hooking mortality of freshwater fish species, Hühn and Arlinghaus (2011) noted that hooking mortality varied by fish species and other factors such as water temperature and use of live bait and barbed hooks.

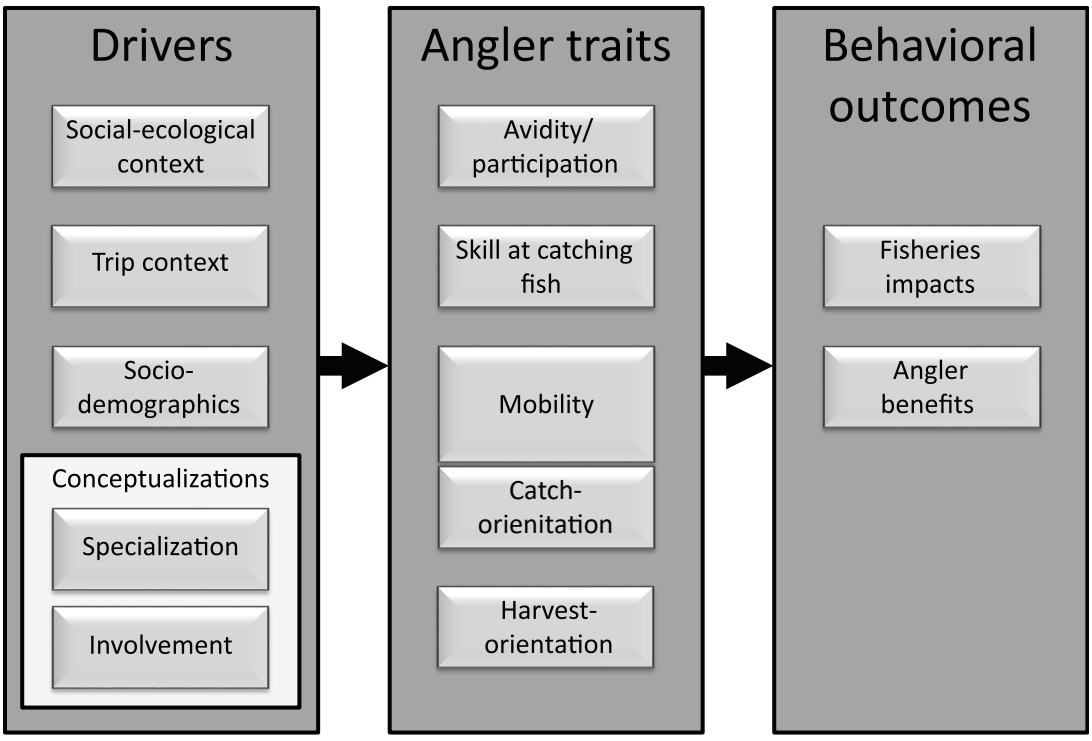

Figure 5.1 Drivers of angler diversity, angler behavioral traits, and outcomes of recreational fisheries.

Other behaviors by anglers can also generally affect aquatic ecosystems (Lewin et al. 2006). For freshwater fisheries, fishing activity is positively associated with the presence of nonindigenous aquatic species (Davis and Darling 2017), and concerns about anglers moving aquatic invasive species (AIS) to new waters is heightened, especially when anglers use live bait (Drake and Mandrak 2014) or travel far distances between fishing sites (Bossenbroek et al. 2001). Anglers also impact ecosystems by creating new access to fishing sites, trampling, producing boat noise, and digging for bait (Lewin et al. 2006; FAO 2012). When fish species have low resilience, even a total catch-and-release fishery can lead to recruitment overfishing over time (Johnston et al. 2013). Thus, assessing how anglers impact fish stocks demands a focus on both angler diversity and the particular ecosystem under consideration (Johnston et al. 2013; Beardmore et al. 2015).

5.2.2 Methods to Measure the Benefits that Anglers Receive from Fishing

Anglers receive benefits to their well-being from fishing activities. While often only implicitly considered in recreational fisheries management (Hunt et al. 2013), these benefits provide the social license for the activity. Measuring these benefits, however, is no simple feat, and researchers from different disciplinary perspectives estimate benefits differently. We focus here on economic welfare and satisfaction, given the prominent application of these measures by resource economists and social psychologists who study anglers.

Economists often equate welfare with efficiency; thus, they prefer markets characterized by perfect competition where buyers and sellers are price takers and the market price is set

where demand and supply intersect. No market per se exists for angling, although exceptions exist including fishing-based tourism destinations, charter, commercial put-and-take fisheries, and the for-hire boat sector (e.g., Hunt et al. 2005; Carter and Liese 2010). Consequently, resource economists almost exclusively use nonmarket approaches to assess how changes to social or environmental conditions affect the economic value of fishing to anglers. The two most common nonmarket approaches are indirect and direct methods (Adamowicz et al. 1994). Indirect methods typically rely on travel cost methods to infer value from the costs that anglers absorb when making decisions about where and how often to take fishing trips. For example, a fishing site that draws many anglers from up to 1,000 km reveals that anglers prefer and value this site more than one that only draws anglers from up to 100 km. In this case, there must be something different and of greater attraction to anglers at the more distant site. Researchers estimate which components contribute to demand by anglers. By converting travel distances and times into monetary costs, researchers can then estimate trade-offs between travel costs and other attributes of fishing sites, such as catch rates and scenic beauty, and thus estimate willingness to pay for these attributes (e.g., Johnston et al. 2006; Melstrom and Lupi 2013). While estimating economic welfare change is slightly more complicated (e.g., one must account for substitution among fishing sites of different quality), the basic premise holds. By contrast, direct methods are based on how hypothetical payments or changing costs affect anglers, their fishing activities, and/or their willingness to pay to avoid or accept changing social–ecological conditions. Direct methods rely on surveys of anglers, and contingent valuation and choice model methods.

Many social psychologists view satisfaction as a proxy for well-being, and even economists view satisfaction as ex post utility, and thus it is highly related to economic welfare (Fenichel et al. 2013). For recreational fisheries, satisfaction is believed to arise when outcomes exceed expectations (Holland and Ditton 1992). Although both catch and noncatch-related factors influence satisfaction, catch, in particular harvest, invokes the largest effects on satisfaction across different angler types (Arlinghaus 2006a). Researchers typically study satisfaction associated with fishing in general at day or season scales, while some applications also focus on satisfaction with catch-related fishing quality (e.g., Beardmore et al. 2015; Ivasauskas et al. 2017).

5.2.3 Effects of Angler Diversity on Fisheries, Ecosystems, and Angler Benefits

Understanding and predicting patterns of fishing activity are important to assess potential effects on fishing resources, aquatic ecosystems, and benefits to anglers. Traditional assessments of angling on fish stocks have relied on general measures of fishing activity, such as aggregated effort; catch efficiency, also termed "catchability"; stock abundance; and, for fisheries with catch–release options, the fate of caught fish, also termed "retention rate" or "hooking mortality rate." Research into the vulnerability of aquatic ecosystems to other angling-related impacts such as AIS spread has also focused on understanding and predicting general patterns of recreational boating activity, of which angling is a large component (Drake and Mandrak 2014). These general patterns of angling activity mask considerable heterogeneity among and within anglers. While researchers have long noted that differing angler behaviors result from a diverse community of anglers (Bryan 1977; Ditton et al. 1992), only recently have researchers illustrated the perils of managing recreational fisheries without accounting for angler diversity (e.g., Johnston et al. 2010; Arlinghaus et al. 2017). Understanding the links between angler diversity and management relevant end points, such as ecological change or anglers' reactions to harvest regulations, is thus a central research frontier in recreational fisheries science (Arlinghaus et al. 2017).

We highlight key behavioral traits related to avidity, skill, cost sensitivity, and catch and harvest orientation (middle section of Figure 5.1) that influence how often and where people fish. For each trait, we provide information about the diversity within the angling community and the effects of the trait on fisheries resources, aquatic ecosystems, and angler benefits (right section of Figure 5.1).

Angler avidity.—Anglers differ in their intensity of participation in fishing. Using information from a survey of resident anglers in Ontario, Canada in 2010 (OMNRF 2014), we see the variability in the reported number of days that anglers fished in the previous year. While these survey responses are affected by recall bias, the results represent a useful illustration. Anglers with the top 25% level of avidity account for 64% of the reported fishing effort, while the 10% and 5% most avid anglers account for 38% and 23% of reported fishing effort, respectively (Figure 5.2). This skewed distribution of angling avidity is a common observation among populations of anglers (e.g., Hutt and Bettoli 2007; Ward et al. 2013).

More avid anglers will disproportionately affect fisheries resources and aquatic ecosystems than will less avid anglers. The greater per capita fishing effort from avid anglers will result in increased catch of fish and increased fishing activity that, in turn, can indirectly impact aquatic ecosystems through behaviors such as moving AIS between water bodies. If avid and nonavid anglers are similar in terms of skill and the importance that they place on harvesting fish, more-avid anglers will also result in greater harvest of fish than will less-avid anglers.

Researchers often assume that commitment to angling is associated with angling avidity (e.g., Ditton et al. 1992). This increased commitment might signal that avid anglers benefit

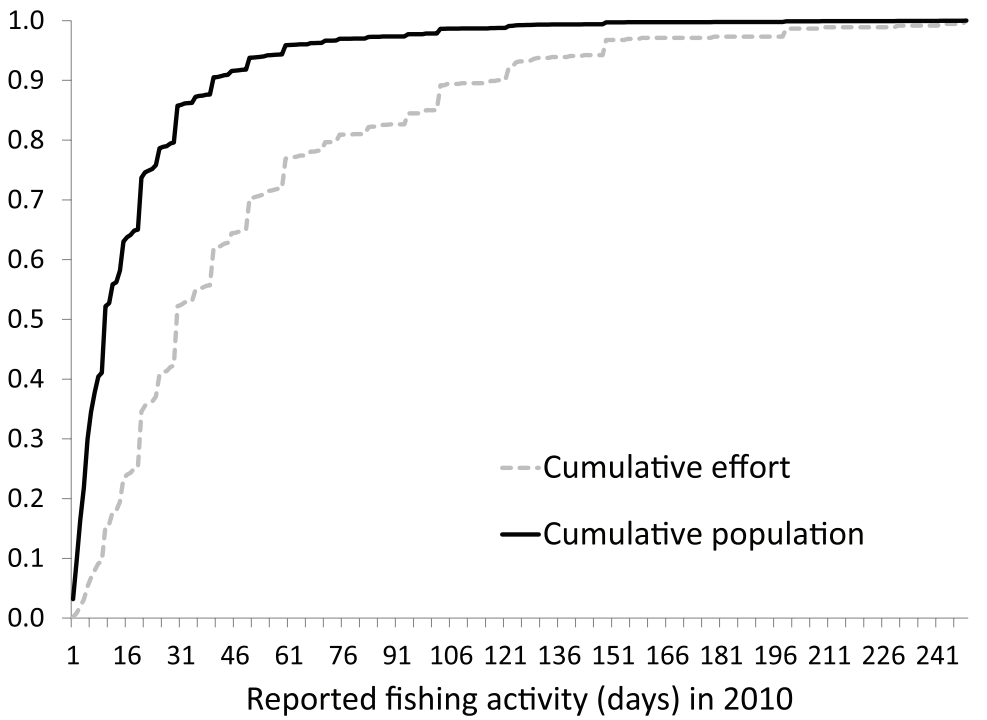

Figure 5.2 Cumulative proportions of number of anglers and total angling effort by reported days fished in 2010 by active Ontario resident anglers.

more from their fishing activity than would less-avid anglers. However, there is considerable uncertainty whether avidity is a useful measure of the psychological commitment of anglers. Framed differently, high-avidity anglers are not necessarily the more specialized as defined by Bryan (1977). Caution is encouraged to using avidity as the only index of angler specialization (Scott and Shafer 2001).

Skill at catching fish.—Anglers vary in their ability to catch fish (e.g., Dorow et al. 2010; Ward et al. 2013), with a usual finding that a small percentage of anglers catch the majority of fish (Baccante 1995). While some researchers suggests that differences in catch rates among anglers arise solely from chance (Seekell 2011), Monk and Arlinghaus (2018) show with an experiment that anglers with greater self-reported skill levels catch more fish than less-skilled anglers, even after controlling for location and lure choice.

Diversity in angling skill is hypothesized to result in effort sorting, whereby skilled anglers are more likely than less-skilled anglers to remain fishing as fish abundance declines (Walters and Martell 2004; Ward et al. 2013). This sorting can result in a hyperstability in average catch rates among anglers, even when fish abundance declines (i.e., as fish abundance declines, skilled anglers remain, resulting in little aggregate effect to catch rates). The retention of skilled anglers at fishing sites where fish abundance declines can result in unsustainable levels of catch and harvest of fish and, ultimately, the collapse of fish stocks (Hunt et al. 2011). Conversely, hyper stable catch rates limit the mobility of skilled anglers and, thus, likely lessen concerns such as the movement of AIS by anglers to different water bodies.

Differences in angling skill can also influence the benefits that anglers receive from fishing. If skilled anglers are better able to catch fish, they will generally be more satisfied with fishing, given that catch rate is positively and strongly associated with satisfaction (Birdsong et al., in press). However, if expectations shift with exceedingly good fishing days, satisfaction of more skilled angles may also decline at constant catch outcomes.

Cost sensitivity.—Angler behaviors are strongly influenced by costs such as license fees, travel costs, and travel time (Hunt et al. 2019). Anglers differ in their sensitivity to these costs, which influences how often and where they fish (Hunt et al. 2019). For example, different anglers are affected by monetary and travel costs when choosing where to fish (e.g., Lupi et al. 2003; Beardmore et al. 2013).

Reduced sensitivity of anglers to cost can either heighten or lessen the effects associated with fishing, depending on the context. Anglers with reduced sensitivity to cost are typically more mobile than are other anglers. Increased mobility affords anglers the luxury to select fishing sites from a larger spatial area and thus increases the likelihood that an angler will choose a fishing site that contains the non-cost-based characteristics that they prefer. In environments rich with fishing resources and poor in angler numbers, increased mobility can diffuse fishing effort, catch, and harvest across a landscape, thus reducing the likelihood of localized impacts to fish stocks (Hunt et al. 2011). In environments where angling populations are larger and/or fishing resources are poorer, increased mobility can spread impacts of exploitation across a landscape, resulting in effects that cascade significant distances from angler origins (e.g., Carpenter and Brock 2004; Post et al. 2008).

Anglers with reduced cost sensitivity can benefit the most from improvements to fishing and are among the most committed anglers to a fishery (Oh et al. 2005; Johnston et al. 2010). This increased benefit arises because economic value depends on trade-offs such as

the amount of money that anglers are willing to spend to fish at sites with greater catch rates. Therefore, holding all other factors constant, anglers who place less importance on cost would be willing to pay more for increases to catch rates than would anglers who are more sensitive to costs. Of course, if reduced cost sensitivity increases angler mobility, this could lead to spread of AIS by these anglers, and AIS can negatively affect the economic value of a fishery (Ready et al. 2018).

Importance of catch and harvest.—Recreation, including angling, is traditionally described as a goal-oriented behavioral process where anglers choose sites to reap expected psychological benefit (Driver and Tocher 1970). The goals of the activity are psychological constructs that are achieved through the choice of an activity or activity style, such as fly-fishing in a specific setting (Clark and Stankey 1979). An important finding from past research based on these psychological constructs is that non-catch-related factors are consistently rated as more important motives to anglers than are catch- and harvest-related factors (e.g., Moeller and Engelken 1972; Driver and Knopf 1976). This finding is contentious, however, and does not easily comport with studies that catch-related factors are indeed critical for the achievement of angling satisfaction (Arlinghaus 2006a). One reason to explain this apparent inconsistency is that noncatch motives are under stronger control by the angler while control of achieving satisfactory catch rates is less (Arlinghaus 2006a). Irrespective of this discussion, we can conclude that anglers vary in the importance that they place on catching (e.g., Lupi et al. 2003; Schumann and Schwabe 2004) and harvesting (e.g., Haab et al. 2012; Lew and Larson 2014) fish.

Increased catch importance results in anglers seeking fishing sites with the greatest expected catch rates (Hunt et al. 2011; Wilson et al. 2020), and it influences anglers similarly to increased mobility. That is, anglers will potentially extend their fishing activities far from their origin if these sites provide high levels of catch-related fishing quality. The resulting landscape is one with an increasingly homogenized catch-related fishing quality surface under certain conditions (e.g., Parkinson et al. 2004; Matsumura et al. 2019). This homogenization effect is strongly moderated by the type of angler present, ecological conditions (e.g., stock–recruitment, target species), and the regional angler population size (Hunt et al. 2011; Matsumura et al. 2019).

Anglers also vary in their harvest orientation. Relative to variation in catch orientation, harvest-oriented anglers will produce larger relative impacts on harvesting fish, given their interest and reduced propensity to engage in voluntary catch and release (Johnston et al. 2010, 2013). Harvest-oriented anglers might also be more specific in terms of targeting fish species (Schroeder and Fulton 2013), as different species provide varying food provisioning benefits to anglers.

Anglers with a greater interest in catch and harvest often report reduced angling satisfaction because these aspects are less under the control of the angler (Fedler and Ditton 1986; Arlinghaus 2006a; Kyle et al. 2007). Thus, compared to other anglers, those who are most interested in catching fish might ironically receive the smallest benefit from fishing. This conclusion, however, depends on the context as the benefits of catch-oriented anglers increase with expected catch rates and the availability of local fishes to capture.

5.3 WHAT DRIVES ANGLER DIVERSITY?

Characterizing any group, including anglers, is fraught with problems. Given the estimate of 118 million anglers in North America, Europe, and Oceania in 2013 (Arlinghaus et al. 2015),

or at least 220 million across the world (World Bank 2012), the reality is that anglers represent all types of people. We argue that any population, and by the same token, any angler population, has the intrinsic tendency to diversify and express different types of people. Besides the influence of personality, contextual conditions foster the emergence and realization of different angler types. For example, if a region lacks salmonids, it is unlikely to produce different angler types fishing for salmonids. We propose that the diversity of anglers and their behaviors that exist in a given locality or region is driven by many factors, including those that vary within anglers (left side of Figure 5.1). To be clear, recreational fisheries are coupled social–ecological systems that include the natural and social systems along with specific stocks such as fish and anglers (Arlinghaus et al. 2017). Critical for these social–ecological systems are connections and feedbacks, such as the fact that people's decisions about fishing can influence fish communities and abundance (see sections 5.2.1 and 5.2.3) and that changing fish communities and abundance can influence anglers' future behaviors through revised expectations for catch (e.g., Fenichel et al. 2013; Ward et al. 2016).

The earlier discussion (section 5.2.3) illustrated the importance of angler diversity with respect to avidity, skill, cost sensitivity, and fish catch and harvest orientation, which all will affect fishing behaviors and outcomes. We focus here on a narrower set of factors related to the social–ecological context, including geographic setting and management context, type of fishing trip, and individual factors such as gender and age.

5.3.1 Social–Ecological Context

A strong driver of angler diversity is the social–ecological context of a fishery. The ecological context can involve factors such as climate, geophysical characteristics, and species, while the social context might involve management and human settlement patterns. Ecological factors influence the number and types of fishing sites available to anglers and the presence and abundance of fish species at these sites. The shape, size, and volume of water bodies (morphological and thermal factors) heavily influence the productivity, diversity, and abundance of fish species (e.g., Mehner et al. 2005). Other morphological factors result in differences such as lentic (still water) and lotic (moving water) systems that, in turn, influence the types and abundance of fish species present. Productivity factors such as nutrient content, mixing, and phytoplankton abundance affect food webs and ultimately abundances of fish populations that anglers target (Downing et al. 1990). Even the resiliency of a given species that is a function of life history traits and of specific populations (e.g., across latitudinal clines) to harvesting can influence conditions that anglers encounter at water bodies (Johnston et al. 2013). Finally, different fish species are vulnerable to capture by angling at different times of the year, different locations, different depths, and through different presentations and types of bait (Lennox et al. 2017). For example, big game pelagic species such as Striped Marlin *Kajikia audax* require anglers to travel significant distances offshore in marine waters, Largemouth Bass *Micropterus salmoides* are available in shallow eutrophic waters with abundant littoral structure, and Chinook Salmon *Oncorhynchus tshawytscha* typically require use of boats and downriggers in oligotrophic systems, except during spawning runs when they are susceptible to shore fishing along river and streambanks. Anglers who target one of these species require different equipment and skill sets, leading to diverse fisheries and fishing styles.

Anglers place different values on catching different species (Johnston et al. 2006; Melstrom and Lupi 2013; Melstrom et al. 2015; Hunt et al. 2019). Relatively rare or difficult-to-ac-

cess big-game pelagic species, such as Blue Marlin *Makaira nigricans* and Sailfish *Isitophorous platypterus* (also known as *I. albicans*), tend to be the most valuable to anglers with willingness to pay exceeding US$1,000 to catch one additional billfish (Whitehead et al. 2013). Within freshwater fisheries (Melstrom and Lupi 2013), Pacific salmonids *Oncorhynchus* spp. tend to be more valuable than char *Salvelinus* spp. and Walleye *Sander vitreus*, which are more valuable than bass *Micropterus* spp. These differences in values also guide angling behaviors, particularly through differences in mobility and importance of catch. For example, in Florida, USA, Camp et al. (2018) noted that anglers typically only traveled less than 30 km to target Common Snook *Centropomus undecimalis*, while anglers would travel more than 200 km to target Red Snapper *Lutjanus campechanus*. Some anglers will also specialize in specific fishes and then almost exclusively target these species, such as many Common Carp *Cyprinus carpio* anglers in Europe (Arlinghaus and Mehner 2003). When fishing conditions deteriorate for the target species, species-specialized anglers usually experience the greatest loss in economic value from reduced catch rates (Dorow et al. 2010).

Climate and climate change currently affect angler diversity through direct effects on the abundance, diversity, and physiology of fish and fish communities (Lynch et al. 2016; Whitney et al. 2016). For example, changes in fish species availability due to climate change may influence the preferred target species of anglers. Some evidence from North American freshwater fisheries suggests that anglers are increasingly targeting species that favor warm over cold water, such as bass over trout and char species (Hunt et al. 2016). These changes to target species can influence harvest orientation, as anglers who target Largemouth Bass and/or Smallmouth Bass *M. dolomie*u in the United States increasingly participate in voluntary catch and release of caught bass over time (Myers et al. 2008), often at voluntary catch-and-release rates greater than for other freshwater species (Pope et al. 2016). These studies suggest that some fish species naturally attract more interest and attention for harvest by anglers than do other species.

Fisheries management is another relevant social–ecological contextual factor that affects angler diversity. In contrast to much of central Europe, a fundamental principle for many recreational fisheries in North America is to view angling as a public right (i.e., open access) with little opportunity for managers to influence where and how often anglers fish (Cox et al. 2002; Daedlow et al. 2011). With few constraints on where anglers are able to fish, open-access fisheries allow for increased angler mobility and possibly alter the importance of catch to anglers. In analogy to the changing baseline condition problem that affects fisheries biologists and managers (Pauly 1995), anglers can become oblivious to the impacts of recreational fishing, resulting in decreased expectations of what constitutes an average or good catch rate for fishing (Arlinghaus and Mehner 2003; Post et al. 2002). This change in the importance of catch rates can result in significant fishing effort remaining at fishing sites with poor levels of catch-related fishing quality (Post et al. 2002).

Human settlement is among the most important social drivers of angler diversity as it provides the raw material for diversity to emerge. Human settlements are not uniformly distributed across continents, countries, or even most regions. An increasing proportion of people reside in urban environments. Urbanization disconnects individuals from nature and creates additional costs to access fishing resources (Hendee 1969; Post et al. 2008; Arlinghaus et al. 2015, 2020), resulting in reduced participation rates for recreational fishing (Hendee 1969; Arlinghaus 2006a; Arlinghaus et al. 2015; Hunt et al. 2017). The negative effect of urbaniza-

tion on angling seems robust to the anglers' country of origin. For example, fishing participation rates for urban residents ranged from one-tenth to two-thirds when compared to rural counterparts in Ontario, Canada (Hunt et al. 2017); New South Wales, Australia (West et al. 2015); and Norway (Aas 1996). The association between degree of urbanization and fishing participation in the United States also seems to have increased between 1991 and 2016 (Figure 5.3A, $r = 0.98$, df = 4, $p < 0.01$), with about a 2.5 times greater participation rate in angling by people living outside metropolitan statistical areas when compared to people living within large (population >1,000,000) metropolitan statistical areas. These results suggest that increasing urbanization will likely reduce participation rates in recreational fishing across the world (Arlinghaus et al. 2015).

Urban anglers appear more mobile than rural anglers (e.g., Carlin et al. 2012; Dabrowska et al. 2017). Given the greater effort needed to reach fishing sites, urban anglers also may take fewer fishing trips than would rural anglers (Federal, Provincial, and Territorial Governments of Canada 2014). These results suggest that the spatial footprint of fishing activities by urban anglers will likely be larger than will be the footprint for rural anglers. However, Matsumura et al. (2019) also suggest that if angler population sizes are similar, urban fisheries maintain and foster diversity while rural fisheries restrict diversity.

5.3.2 Trip Context

The same angler does not always behave the same, even if resource conditions are the same. In these instances, the angler is influenced by factors that vary among trips that are largely in control of the individual angler. One factor is the duration of the fishing trip. Trips completed in a single day might involve different expectations and behaviors than trips that are completed over the course of multiple days. Multi-day trippers appear more mobile and more influenced by catch-related fishing quality than are day trippers (Lupi et al. 2003; Dabrowska et al. 2017). These multi-day trippers might also be more harvest-oriented than day trippers, as measured by increased preference for greater bag limits in British Columbia (Dabrowska et al. 2017). With greater levels of mobility and increased interest in catch-related fishing quality, multi-day trippers might behave more akin to natural predators in a predator–prey system than would day trippers who are spatially constrained to nearby available fishing sites. This predator characterization might help to explain why multi-day trippers who are tourist anglers often seek sites located in remote areas away from significant local angling pressures (e.g., Hunt et al. 2005). Given that researchers often exclude multi-day trippers from investigations of angler behaviors (e.g., Haab et al. 2012; Melstrom and Lupi 2013), conclusions from past studies of angling might result in misguided conclusions about the importance of catch at influencing anglers' behaviors.

Other trip contextual differences include companionship, mode (e.g., boat, shore, and ice), and style (e.g., fly-fishing and other gear choices). Individuals traveling with family are more likely to substitute other leisure activities for angling than are people traveling with nonfamily companions (Choi et al. 1994). It is also likely that people fishing with young children might select fishing sites more conducive to catching fish than to catching the desired fish species for harvest. The type of fishing party can also influence the degree of agency that anglers have in making decisions about where to fish and what to target. The same angler can at times be the leader or follower within a group, thus influencing the role that the individual has in deciding where to fish and how and what to target.

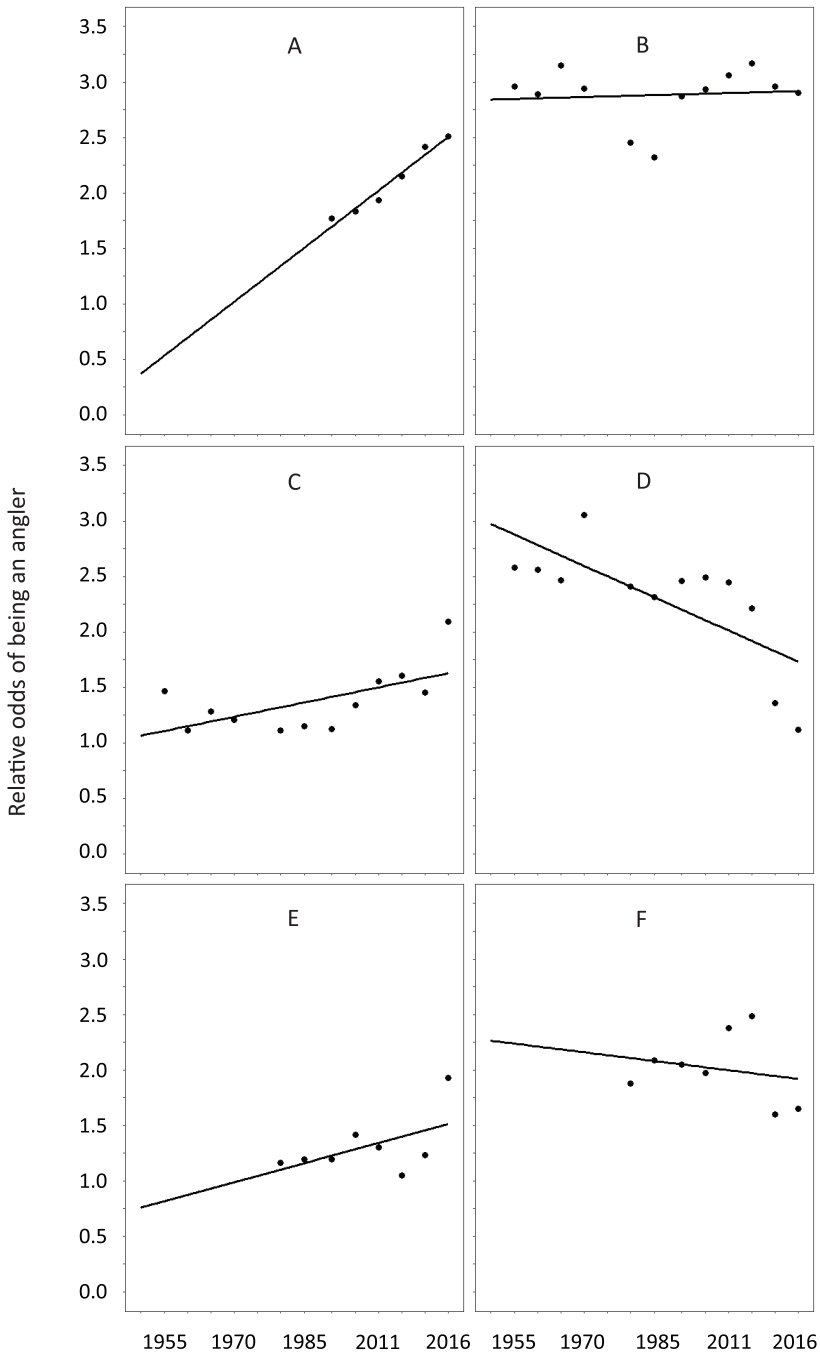

Figure 5.3 Relative odds of subpopulations being an angler identified by U.S. national surveys of fishing (USFWS 1955–1970; USFWS and U.S. Census Bureau 1980–2016) (relative odds = PR_1/PR_2, where PR is the percentage of all individuals from subpopulation 1 or 2 that are anglers; **(A)** nonmetropolitan statistical area resident rural versus large metropolitan statistical area resident, **(B)** males versus females, **(C)** 45–54- versus 18–24-year-olds, **(D)** 45–54 versus 65 years and older, (E) five plus years of college/university versus less than secondary school graduate, **(F)** Caucasian versus African American).

Catch is a more important factor for anglers participating in fishing tournaments than anglers pursuing other trips (Loomis and Ditton 1987; Falk et al. 1989). These tournament anglers are often more avid than are other anglers and, at least anecdotally, are believed to be less sensitive than other anglers to travel to access fishing sites.

The style of fishing affects decisions by anglers about retaining caught fish. Fly-fishing anglers are less influenced by harvest-related outcomes, including support for bag limits, than are anglers using different fishing styles (Kershner and Van Kirk 1984; Aas et al. 2000).

*Sociodemographic characteristic*s.—Several countries and states conduct surveys of their angling population to better understand the characteristics and behaviors of anglers. We draw inferences here from reports based on angler surveys in the United States between 1955 and 2016 (USFWS 1955–1970; USFWS and U.S. Census Bureau 1980–2016). While the summarized statistics within the reports are not always directly comparable (USFWS and U.S. Census Bureau 2016), the ratios of participation rates from one angling subpopulation to another (e.g., males and females) are likely comparable. This belief follows the assumption that methodological changes in surveying should not change the estimated odds of being an angler between two subpopulations. By comparing trends between angling participation and sociodemographic characteristics, we can understand how changing demographics might change the diversity of angling populations. We also provide information that describes relationships between these angling populations and angler behavioral traits that affect fisheries and the benefits that anglers receive from fishing. The analyses and discussion below are purposively descriptive and they do not address how history, including culture, has shaped the associations between demographic characteristics and fishing-related behaviors.

The generality of the results from the U.S. surveys is evaluated from reports based on anglers from Canada (Fisheries and Oceans Canada 2012), Australia (West et al. 2015), and Germany (Arlinghaus 2006b), along with other research publications. These additional sources are used to help evaluate whether the results from U.S. anglers are representative of a larger population of anglers. Of course, the reliance on studies of anglers who reside in wealthier countries limits our ability to generalize the results to all communities of anglers. We also present information about each sociodemographic characteristic on participation independently from other factors. Readers are forewarned that these characteristics often combine synergistically in affecting angling participation (Lee et al. 2016).

From the 2016 survey of U.S. anglers (USFWS and U.S. Census Bureau 2016), anglers are relatively more likely than nonanglers to be middle- to older-aged Caucasian males who reside outside of large metropolitan areas (see Table 5.1). Among these characteristics, gender appears to be an important determinant of who is an angler (Arlinghaus 2006b). Similar to the estimate of American anglers, surveys from Canada (Fisheries and Oceans Canada 2012), Germany (Arlinghaus 2006b), and New South Wales, Australia (West et al. 2015) estimate that males are at least 2.5 times more likely to be anglers than are females.

The disparity in fishing participation rates between U.S. males and females in 2016 seems to have been constant over time. Using reported participation rate in angling data from 12 surveys between 1955 and 2016, year was not associated with the ratio of male to female participation rates ($r = 0.09$, df = 10, $p = 0.77$). Overall, the ratios ranged from a low of 2.3 in 1985 to 3.2 in 2006 (Figure 5.3B).

The absence of a trend between gender and year from the U.S. data is consistent with other locations. Aas (1996) concluded that the ratio of male and female participation rates in Nor-

wegian angling has not changed from 1970 to 1993. In Ontario, Canada, the estimated ratio of male to female participation in angling was only 1.5 in 1970, but older data suggest that 92.8% of fishing trips in Ontario in 1959 were taken by males (Cox and Straight 1975). The obvious conclusion from the analyses and studies is that gender imbalances in rates of angling participation have not improved.

In general, women appear less interested in fishing than men (Kellert et al. 2017) in part because of gender differences in perceived leisure time available and concerns about safety (Floyd et al. 2006). Males tend to be more-avid anglers than females (Montgomery and Needleman 1997; Lupi et al. 2003; MacNair and Desvousges 2007; Larson and Lew 2013; see Morey et al. 2002 for an exception). Harvesting fish, however, appears more important to women than to men (Grambsch and Fisher 1991; Schroeder et al. 2006).

Age is another key sociodemographic variable related to fishing participation in the United States, but not in Germany (Arlinghaus 2006b). In many industrialized nations, age distributions, especially among anglers, are increasingly skewed toward older individuals (Ensinger et al. 2016). Consequently, the effects of an older population might be profound in terms of participation, effort, revenue from license sales, and impact. Among the adult population, U.S. anglers were less represented by younger and older individuals than by people aged 25–64 (USFWS and U.S. Census Bureau 2016). However, fishing participation rates were the greatest among children aged 12–15 (1970, 2010) when compared to any other age cohort. This conclusion is consistent with results from New South Wales, Australia, where children between 5 and 14 years old were estimated to be 1.5 times more likely to be anglers than were individuals aged 30–44, who had the next highest angling participation rate (West et al. 2015). Information from Ontario, Canada in 1970 also supports this conclusion, as boys and girls (18 years or younger) were about 1.7 times more likely to be anglers than were men and women, respectively (Cox and Straight 1975). The greater participation rates by children than adults likely reflects the relatively larger-sized leisure budget that most children have when compared to adults.

Strong trends exist between 1955 and 2016 in the ratios of participation rates for angling among different age cohorts (Figure 5.3C and 5.3D). The participation rate in angling among 35–44-year-old individuals is greater than the rate for 18–24-year-old individuals, and this rate difference has increased from 1955 to 2016 ($r = 0.61$, df = 10, $p = 0.03$). While the participation rate in angling among 35–44-year-old individuals is greater than the rate for 65 years and older individuals, this difference declined from 1955 to 2016 ($r = -0.73$, df = 10, $p = 0.01$). These results suggest that the distribution of the population of U.S. anglers has shifted over time to become much more elderly in nature.

Age is often important at influencing trip taking, but its effect is variable, with some studies reporting a negative relationship (Ahn et al. 2000; Breffle and Morey 2000; Bingham et al. 2011; Larson and Lew 2013), while others reporting a positive relationship (Shaw and Ozog 1999; Morey et al. 2002; Lupi et al. 2003). Catching fish appears more important to younger anglers than to older anglers (Moeller and Engelken 1972; Hicks et al. 1983; Kershner and Van Kirk 1984; Loomis and Warnick 1992).

Angling participation and income are usually positively related (Floyd and Lee 2002; Arlinghaus 2006b; Thunberg and Fulcher 2006; Lee et al. 2016). Results from the 2016 *U.S. National Survey of Fishing, Hunting, and Wildlife-Associated Recreation* (USFWS and U.S. Census Bureau 2016) do not support this conclusion, as a nonsignificant association exists between participation rate and household income ($r = 0.22$, df = 8, $p = 0.52$). Harvesting fish, neverthe-

less, appears more important to monetarily poorer than wealthier anglers and to certain ethnic groups and races (Grambsch and Fisher 1991; Schramm and Gerard 2004; Hunt et al. 2007). This result might imply that for wealthier anglers, food provisioning services of fishing are less important than they are for other anglers.

Unlike income, the effect of education on angling participation is less certain, with some researchers finding no association (Floyd and Lee 2002; Floyd et al. 2006) and others concluding that a negative association exists (Arlinghaus 2006b; Thunberg and Fulcher 2006). From U.S. national survey data (USFWS 1955–1970; USFWS and U.S. Census Bureau 1980–2016), ratios of fishing participation rates by individuals with five or more college years compared to individuals with less than 12 years of education ranged from 1.0 in 2006 to 1.9 in 2016 (Figure 5.3E), with no significant association over time ($r = 0.53$, df = 6, $p = 0.18$).

Finally, race is related to angling participation rates as Caucasians were much more likely than non-Caucasians to participate in fishing in the United States (Floyd and Lee 2002; Floyd et al. 2006; Thunberg and Fulcher 2006). In 2016, the ratio of fishing participation rates of Caucasians to African Americans was 1.8 (Figure 5.3F) with no evidence of any change over time ($r = -0.21$, df = 6, $p = 0.62$). However, after accounting for interactions between race and income, and race and education, Lee et al. (2016) concluded that the main effect of race on fishing participation was nonsignificant. In their study, income was more important and a positive factor, while education was more important and a negative factor for freshwater fishing participation in the United States among non-Caucasians compared to Caucasians.

5.4 WHAT CONCEPTUALIZATIONS OF ANGLER DIVERSITY EXIST?

Researchers have developed integrative perspectives about angler diversity through measures of the commitment or personal relevance that individuals have toward the activity. We describe two related perspectives: specialization and enduring involvement (left side of Figure 5.1). Specialization has more frequently been applied to study anglers as it was first described from empirical observations of trout anglers (Bryan 1977). Enduring involvement has a stronger theoretical underpinning than specialization, but it has been less frequently applied to describe anglers. We define specialization and enduring involvement and describe the expected relationships between the concepts and the behavioral traits. Some descriptors of angler diversity mentioned in section 5.2 form integral parts of the diversity concepts here and can be empirical measures to score the type of angler.

An often-cited idea within communities of angler diversity is the progression or evolution of the angler (Bryan 1977). Clearly, the most committed and invested anglers began as novices, but how reasonable is it to assume that all anglers progress to become more committed to fishing over time (Kuentzel and Heberlein 2006)? We answer this question below.

5.4.1 Specialization

Bryan (1977), who is credited with introducing the specialization framework to the literature, defined specialization as a "continuum of behavior from the general to the particular, reflected by equipment and skills used in the sport, and activity setting preferences." His initial work focused on trout fishing and his goal was to provide fisheries managers and researchers with a conceptual tool for understanding and investigating diversity among anglers. As Bryan noted, "A major weakness of past research efforts has been the assumption of sportsmen homogeneity, with variations among individual sportsmen remaining largely unexplored."

Along the specialization continuum, characteristic styles of involvement are thought to exist. Bryan (1977), for example, theorized that there are four categories of trout anglers: occasional anglers, generalists, technique specialists, and technique setting specialists[1]. These angler types were put forward to provide fisheries managers and researchers with a comparative tool for examining behaviors along a continuum of fishing specialization. The idea of Bryan was that there were characteristic attitudes and preferences associated with a given specialization level (i.e., by knowing the specialization level, one could foresee the ethical and moral assumptions, setting and management preferences, and behaviors of a given angler).

Bryan argued that recreation specialization was a development process that entails a progression in how people participate and view fishing over time (Scott and Shafer 2001). Bryan assumed that as anglers move from one stage of involvement to another, they become increasingly skilled and take on the attitudes and behaviors of fellow specialists. He also postulated that anglers' interests evolve, as reflected by increased emphasis on the setting and quality of the experience, and that anglers would change from a focus on stocking and catching a lot of fish to a focus on habitat management and a tendency to engage in catch-and-release behaviors. To date, however, most studies that have examined specialization in the context of fishing have treated the concept as an independent variable with the goal of predicting other facets of involvement, such as attitudes to management, rather than elucidating the progression idea proposed initially.

Catch- and particularly harvest-related outcomes are hypothesized to be less important for specialized than less-specialized anglers (Bryan 1977; Ditton et al. 1992). Studies of different angler populations have documented that as anglers become increasingly specialized, they tend to be less focused on consumption and more likely to embrace catch-and-release regulations (Chipman and Helfrich 1988; Ditton et al. 1992; Arlinghaus et al. 2007). Specialized anglers, however, appear to be more trophy-focused than other anglers (Siemer and Brown 1994; Hutt and Bettoli 2007). Several more recent studies by contrast suggest that some specialized anglers are more influenced by catch and harvest regulations than are other anglers, suggesting that catch and also harvest components matter for specialized anglers who target certain species (Dorow et al. 2010; Beardmore et al. 2013; Dabrowska et al. 2017). It seems that the role of specialization and catch and harvest orientation might be context dependent (e.g., targeting harvest-oriented species such as European Eel *Anguilla anguilla* or stocked Rainbow Trout drives these variations in the importance of catch and harvest to specialized anglers).

Greater levels of specialization are also associated with the unwillingness of anglers to substitute fishing with nonfishing activities (Choi et al. 1994), a greater willingness to pay for the conservation of fisheries resources (Oh et al. 2005), larger media interaction (Ditton et al. 1992), and greater support for management policies that are designed to reduce adverse user impacts (Oh and Ditton 2006). The latter, however, seems to be confined to output regulations such as acceptance of size-based harvest limits or daily bag limits, as it does not necessarily involve greater acceptance of personal constraints on access (Salz and Loomis 2005; Dorow et al. 2010). This result is understandable, as greater specialization means people have more to lose. Thus, strong constraints on enjoying the activity through temporal or spatial closures are felt more strongly than constraints on harvesting opportunities introduced through regulations such as bag limits.

[1] Note that specialization does not refer to the target species of the angler.

A limitation of angling-related specialization research is that scholars have not explicitly defined level of specialization. Although researchers agree that specialization entails both attitudinal and behavioral components, they have employed a myriad of indicators to measure the concept, including frequency of participation (avidity), past experience, general experience, level of commitment, economic investments, centrality to lifestyle, membership in fishing clubs and organizations, enduring involvement, media involvement, and angling skills. Scott and Shafer (2001) examined extant research and concluded that specialization should be conceived and measured using three dimensions: (1) a focusing of behavior, (2) the acquiring of skills and knowledge, and (3) personal and behavioral commitment. These dimensions resemble the three dimensions put forth by McIntyre and Pigram (1992): (1) behavior (e.g., prior experience and familiarity), (2) cognitive (e.g., skills and knowledge), and (3) affective (e.g., enduring involvement). Each of these approaches to define and operationalize specialization borrow extensively from the involvement and commitment literatures (Scott 2016). While the debate is ongoing, the recommendation is to try to operationalize all three dimensions as, for example, measuring specialization by just behavioral commitment, such as number of days participating, does not necessarily correlate with the underlying angler ethics and attitudes to management.

Little doubt exists that some anglers progress to an advanced stage of participation. These individuals, in the words of Bryan (1977), "have in effect joined a leisure social world—a group of fellow sportsmen holding similar attitudes, beliefs, and ideologies, engaging in similar behavior, and having a sense of group identification." This progression, however, may be the exception rather than the rule. A study of Texas saltwater anglers showed that progression is not a typical career trajectory, and many participants follow a pattern of stability or decline over time (Oh et al. 2010). Results from that study confirm findings from studies of boaters (Kuentzel and Heberlein 2006), mountain bikers (Shafer and Scott 2013), and birdwatchers (Scott and Lee 2010). Various life course events, such as the birth of a child, and career contingencies, such as support from significant others, make progression problematic (Scott and Shafer 2001). Furthermore, some participants eschew progression and are content to participate at a continued low level (Scott 2016). These individuals use skills acquired early in their leisure career and are not driven to upgrade their equipment or techniques. It is unclear what predisposes a person to become either highly specialized or to be recruited and maintained at a low participation and development level. This is certainly a very interesting area of research.

5.4.2 Enduring Involvement and Commitment

Another related line of research emanating from the psychology and consumer behavior literatures has examined recreationists' enduring psychological ties to leisure. This research, falling within the domain of enduring involvement, has focused exclusively on the attitudinal dimensions of leisure participation. Typically defined in terms of the degree to which recreationists consider the activity to be personally relevant (Havitz and Dimanche 1990), contemporary conceptualizations make few assumptions about continuum spectrums or progressions. Because leisure experiences vary across individuals in terms of both the reason and intensity of personal relevance, enduring involvement researchers typically construct involvement profiles that provide insight on the meaning of the activity for the individual (Dimanche et al. 1993; Havitz and Dimanche 1997). Facets most commonly conceptualized and measured address

elements tied to identity (expression and affirmation), to the centrality of the activity within the context of the recreationist's lifestyle, to the emotional attraction of the activity for the individual, and to the social bonds the individual has with others associated with the activity (Havitz and Dimanche 1997; Kyle et al. 2007). Surprisingly, in spite of considerable conceptual overlay between enduring involvement and specialization, with few exceptions, researchers studying the human dimensions of recreational fishing have yet to adopt the construct despite widespread use in other outdoor recreation contexts (Perdue 1993).

The shared space between involvement and specialization research is most firmly grounded in researchers' conceptualization and measurement of attitude (e.g., centrality and attraction). Some early research (McIntyre and Pigram 1992) used involvement and specialization interchangeably. Beyond this commonality, however, conceptual distinction is most salient in the manner in which behavior is addressed. As outlined above, conceptualizations of specialization situate its dimensions (i.e., behavior, cognition, and affect) on the same temporal plane (Scott and Shafer 2001). Involvement researchers, however, consider behavior to be an outcome of a cognitive hierarchy (Figure 5.4). This assumption is an artifact of the construct's theoretical development anchored in the ontology of psychology (Pritchard et al. 1992; Iwasaki and Havitz 1998). As such, involvement is considered to be an antecedent of behavior. The process reflected in Figure 5.4 implies that with increasing involvement, recreationists develop more complex cognitive structures, resulting in a resistance to change and, ultimately, behavioral consistency. Operationally, where involvement is conceptualized and measured at the "brand" level, psychological commitment is conceptualized at the "product" level (Iwasaki and Havitz 1998). Consequently, the attitude object referenced in measures of involvement will focus on the activity of concern (e.g., fishing, fly-fishing, and noodling). Alternately, measures of psychological commitment reference specific psychological outcomes that are associated with increasing involvement, such as more pointed preferences for setting types (Kyle et al. 2004), angling equipment, or consumptive orientations (Kyle et al. 2007). In this sense, increasing involvement leads to the development of a broad awareness set of activity-related attributes (e.g., settings types, equipment alternatives, and styles of participation). From this awareness

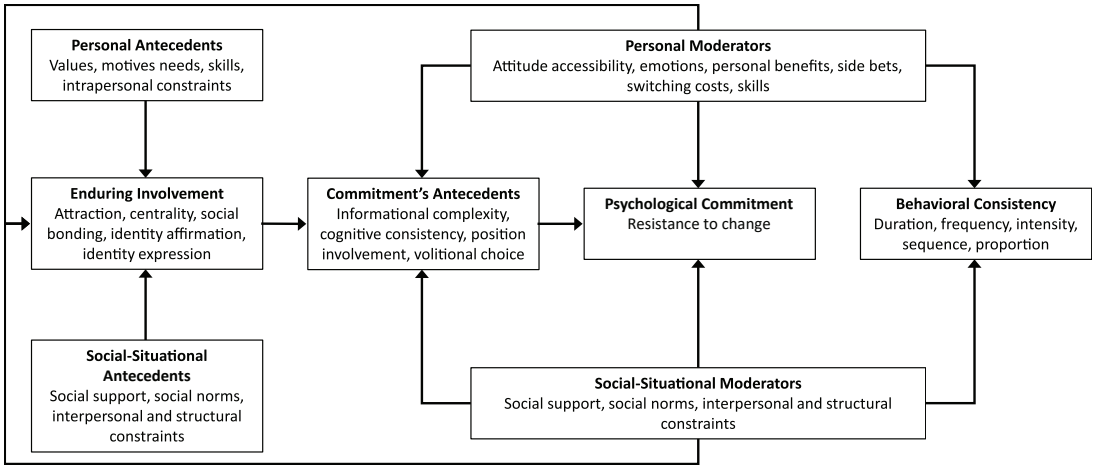

Figure 5.4 Conceptual model of the social–psychological drivers of behavioral consistency. Adapted from Iwasaki and Havitz (1998).

set, however, the evoked set of viable activity-related alternatives is markedly narrower in that recreationists develop greater specificity in the leisure preferences.

Much of the literature exploring involvement-related outcomes has focused on accounting for attitudinal and behavioral outcomes across a range of activity contexts (Havitz and Dimanche 1997). As noted, very little work has been conducted in the context of recreational fishing (Kyle et al. 2007; Schroeder et al. 2018). One area of involvement research that has proven to be fruitful for understanding diversity among recreationists and that has demonstrated utility for management is the use of recreationists' involvement profiles to segment various populations. This research (Dimanche et al. 1993; Havitz et al. 1994; Kyle et al. 2002) has consistently demonstrated that emergent segments do not typically differ linearly from low to high across the different facets of involvement. Rather, because the involvement facets (i.e., attraction, centrality, social ties, identity expression, and affirmation) abstractly capture the reasons why an activity is personally relevant, the emergent segments often score high on one or more facets and low on others. As such, the meaning of the activity for the segments varies, which has managerial and behavioral implications (e.g., consumptive orientation, setting preferences, and avidity). Consequently, while an individual's commitment to angling can progress in the manner reflected in the model and that occasionally reported in specialization research, the manner in which the progression is manifested has different attitudinal and behavioral outcomes. This progression is more likely to occur via different styles of participation. As discussed throughout this chapter, in context of angling, the manner in which anglers engage the resource can vary in so many different ways, many of which have little to do with their level of specialization.

An additional area for future involvement research on angling is the use of behavioral models that draw from the same ontological and epistemological tradition implied in Figure 5.4. For example, Ajzen's (1985) theory of planned behavior, Schwartz's (1977) norm-activation model of behavior, and Stern et al.'s (1999) value-belief-norm theory all assume a cognitive hierarchy similar to that reflected in Figure 5.4. The inclusion of involvement and related constructs within these models, consequently, would likely boost their ability to account for variation in a variety of target behaviors. We do not suggest abandoning existing models like specialization; four decades of research has demonstrated its utility for understanding diversity among anglers. Rather, the concepts depicted in Figure 5.4 offer an alternate and, to date, underutilized approach within the human dimensions of fisheries management. Because anglers vary in their management preferences, it is reasonable to suspect that different approaches to capturing angler diversity might also be fruitful.

5.5 WHAT DOES THE FUTURE HOLD FOR ANGLER DIVERISTY?

We highlighted the extent of, drivers of, and effects of angler diversity on behavioral traits and fisheries outcomes. An obvious remaining question is what does the future hold for angler diversity. We speculate here on the future given observed trends in recreational fishing.

5.5.1 Projections of Main Drivers of Diversity

Diversity is largely driven by contextual and individual characteristics, including the personal commitment and/or relevance of the activity to the individual. Within the social–ecological context, increased human settlement and urbanization are of prime consideration. Human population growth has the potential to increase effects on fisheries through sheer change to numbers of fishers. This population growth, however, is not haphazard and is expected to re-

sult in increased urbanization and a larger share of the 65 years and older population (World Bank 2018).

Urbanization has a multifaceted effect on angler diversity. Urbanites are less often engaged in angling, and those who fish do so less intensely than their rural counterparts (Federal, Provincial, and Territorial Governments of Canada 2014). Consequently, urban anglers are less likely to be committed to recreational fishing than their rural counterparts. This tendency for reduced levels of participation and commitment can result in reduced overall participation rates in recreational fishing and/or increasing management actions to encourage participation through urban-based fisheries and youth engagement programs. A reduction in participation can influence the relevance of the activity both in terms of its impact to societal benefits and importance.

As stated earlier, urban anglers appear more mobile than rural anglers (Lupi et al. 2003; Dabrowska et al. 2017) and likely engage in multi-day trips and angling tourism adventures at greater rates than their counterparts (Arlinghaus et al. 2008). This increased mobility can serve to extend impacts of recreational fishing to areas far removed from the origins of most anglers and may also increase demand for angling tourist destinations.

People might, on average, experience longer and healthier lives due to improvements in the prevention and treatment of diseases. Currently, angling participation rates in the United States is reduced by about half at 75 years of age when compared to the rate for those who are 65–74 years of age (USFWS and U.S. Census Bureau 2011). An increasingly older and healthier population might change these thresholds for participation in angling. To tap into this latent demand, fisheries might need to be managed better to accommodate people with disabilities by developing more accessible sites for these anglers.

Changes in leisure behavior exist among the new generation that compete with outdoor recreation (videophilia hypothesis) and has reduced participation in outdoor recreation in general (Pergams and Zaradic 2008). Individual level resources affect future fishing participation, in particular, physical resources, time, and money. Much research since the early 1990s has linked demographic changes to fishing participation using household samples from the United States and Germany. Demographic changes predicted to happen mainly included aging and a rise in education and possibly income. Systematic changes in all these factors are bound to affect interest in fishing participation, although the actual predicted effects are less clear because of uncertainty in how generally aging, education, and income scale with fishing participation. Early work by Murdock et al. (1992) predicted that fishing participation in the United States would decline given an aging population, which on first sight seems to correlate with the actual declines seen in recent years. Whether the declines were caused by demographic change or by structural changes in society, however, remains unclear.

Work from Germany outlines the difficulty in projecting future angling participation. In 2006, Arlinghaus published predictions that angling participation should decline due to (1) an aging population, (2) more unemployed people, (3) reduced income, (4) increased urbanization, and (5) a sustained shift from Eastern Germany to Western Germany. Since 2002, however, the angling participation rates were stable and recently increasing and some of the implied structural changes have not taken place.

5.5.2 Opportunities and Challenges of Angler Diversity

We acknowledge that diversity makes it difficult to apply one-size-fits-all regulations to all fisheries and anglers. Diversity might require greater efforts by fisheries managers to tailor

their approaches to the specific context that they face (Johnston et al. 2010, 2013). It is simply impossible to generate optimal fishing experiences for each angler type with uniform regulations and management approaches. One opportunity is to strategically vary policies in space and let anglers self-sort according to angler type (Ensinger et al. 2016; van Poorten and Camp 2019). Whether or not this tailoring of management actions is a cost or a benefit is a normative question that each fisheries manager must answer. Certainly, the omission of angler diversity from fisheries management models has been repeatedly identified as a major omission that can seriously undermine management effort by leading to surprises (Johnston et al. 2010, 2013). For example, Matsumura et al. (2019) showed that a diverse angler population exerts greater cumulative impacts on resources than a homogenous population.

Diversity among anglers and fishing styles serves a functional purpose. Diversity of ecosystems is often equated with stability and resilience in ecological contexts (Ives and Carpenter 2007). The basic premise is that the greater the level of diversity, the better a system is able to absorb stresses such as climate change or species invasions. Thus, the extent of diversity among anglers may help to ensure that recreational fishing can persist and adapt despite stresses that affect some social and ecological dimensions of fishing. This adaptation might occur from the same ingenuity that has produced such a rich mosaic of recreational fisheries across the planet that are characterized by diverse anglers and fishing styles. Of course, some social and ecological stresses will likely swamp the adaptive capacity of anglers.

Voluntary catch and release is increasingly common within some fisheries (e.g., Myers et al. 2008). The increasing drift of angling from quasi-subsistence to pure recreation likely is in response to increasing human settlement, the fact that anglers tend to be wealthier than nonanglers, and exploitation concerns with a more harvested-oriented fishery. Thus, norms (i.e., standards for behavior guided by shared morals and informal sanctions) develop within the community of anglers to release caught fish, particularly among more specialized anglers.

On the other hand, the presence of diverse anglers also spreads effort more in space (Matsumura et al. 2019). Put simply, a population with travel prone specialized and less travel prone consumptive anglers will exert different fishing pressures than a more homogenized angler population composed of just one angler type. The presence of angler diversity, in short, aggravates regional overfishing (Hunt et al. 2011; Matsumura et al. 2019), which can reduce ecological resilience while increasing social resilience.

5.5.3 Concluding Remarks

Angler diversity is widespread among recreational fisheries throughout the planet. Angler diversity is reflected in patterns driven by social–ecological context, trip context, individual characteristics, and, more generally, the commitment or personal relevance of the angler to the activity. Despite this diversity, little support exists for the idea of the progression evolution of an angler. Instead, some anglers will evolve to a more committed state to the activity while others will remain content to be less specialized.

Drivers of angler diversity affect key behavioral traits of anglers that, in turn, impact fisheries resources and the benefits that anglers receive. Of these traits, we see angling avidity, skill at catching fish, angler mobility, and catch and harvest orientation as instrumental at influencing outcomes to fisheries and to anglers. While some research has connected drivers of angler diversity to these traits, much more research is needed. Additional research can help fisheries managers to better understand under what contexts these drivers are more or less influential at

impacting fisheries. Finally, the presence of angler diversity is so pervasive that fisheries management and development activities might only be sustainable when they account for diversity specifically. While this call is by no means new, there remains much to improve in the approaches we use to assess, measure, and account for angler diversity in fisheries management.

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