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Authors: Havird, Justin C., Parker, Jennifer K., and Connery, Bruce

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Fishes of the Streams of Acadia National Park, Maine

Justin C. Havird[1,*], Jennifer K. Parker[2], and Bruce Connery[3]

Abstract - Acadia National Park (ANP) is a non-continuous conglomerate of park lands interspersed with private lands, which is located mainly on Mount Desert Island, ME. Surveys of fishes in ANP have largely ignored or under-sampled most of the streams on the island. Reported here are the results of a 2009 survey that sampled freshwater fishes in 43 streams flowing through Park boundaries. Overall, 19 species were collected, and many were recorded from specific streams for the first time. *Notemigonus crysoleucas* (Golden Shiner) was the most widely distributed species (47% of surveyed streams), while *Pimephales promelas* (Fathead Minnow) was recorded from ANP for the first time as a recent bait-bucket introduction. This survey provides an updated baseline for ANP stream fishes and will be used to identify streams for restoration and measure the impacts of future environmental perturbations.

Introduction

Acadia National Park (ANP), mainly located on Mount Desert Island (MDI), ME, is home to a diverse assemblage of freshwater fishes. Although some surveys have targeted specific water bodies in ANP (Burgess 1995, Doering et al. 1995, Havey 1952), very few surveys have attempted to catalog the complete diversity of freshwater fishes in the Park. Early Park-wide studies by Batchelder (1927), Fuller and Cooper (1946), and Procter (1933) targeted only small, specific regions of ANP, sampled only lakes and ponds, or failed to identify many minnows and other small species. The Maine Department of Inland Fisheries and Wildlife (MDIFW) has monitored several ponds and lakes in ANP since 1940 (Stone et al. 2001), but these efforts have given little attention to non-game species.

The last Park-wide freshwater fish surveys in ANP and adjoining lands occurred during 1998 and 1999 (Moring et al. 2001, Stone et al. 2001). Although lakes and ponds were the major focus of the 1998 and 1999 surveys (all but four small ponds were sampled), 32 streams were also surveyed. Twenty of those streams had not previously been sampled, and many others had not been sampled for several decades (Moring et al. 2001, Stone et al. 2001). The 1998 and 1999 surveys documented 28 species of fishes throughout the freshwaters of ANP, of which 15 species were native (Stone et al. 2001).

Although the 1998 and 1999 surveys were the first thorough Park-wide assessments of freshwater fishes in ANP, they likely underestimated fish diversity in ANP streams. Several large streams (e.g., Cromwell Brook, Jordan Stream, and Kebo Brook) on the eastern side of MDI were not sampled, and many others were only partially sampled (Moring et al. 2001, Stone et al. 2001). Sampling methods

[1]Department of Biological Sciences, Auburn University, 101 Rouse Life Sciences Building, Auburn, AL 36849. [2]Department of Entomology and Plant Pathology, Auburn University, 209 Rouse Life Sciences Building, Auburn, AL 36849. [3]Acadia National Park, National Park Service, Bar Harbor, ME 04609. [*]Corresponding author - jhavird@auburn.edu.

for ponds were diverse (Stone et al. 2001), but stream sampling was often limited to electrofishing short (i.e., 100-m) stream reaches, preferentially in riffle or run habitats. These methods and sampling sites likely biased collections towards larger species such as *Salvelinus fontinalis* (Brook Trout) and *Anguilla rostrata* (American Eel), the two most common species found in streams during the 1998 and 1999 surveys (Stone et al. 2001). Additionally, only "uncommon" fishes were retained as vouchers to confirm field identifications (Stone et al. 2001), and tissue samples were not preserved as genetic resources. Such shortcomings are unfortunate because they resulted in only a rudimentary baseline of ANP stream fishes and hindered future investigators in documenting and understanding changes in fish assemblages since that time.

To gain a better understanding of the freshwater fishes in the streams of ANP, a Park-wide survey of ANP streams was conducted during June and July 2009 using a variety of sampling techniques. Some streams were sampled for the first time, and many were sampled along their entire lengths. Comparisons are made between this survey and the 1998 and 1999 surveys.

Field-Site Description

Acadia National Park (centered at 44°21'N, 68°13'W) is a non-continuous assortment of park lands interspersed with private lands (Fig. 1). It encompasses approximately 55% of MDI (15,233 ha) and includes small tracts on Isle au Haut, the Schoodic Peninsula, and small neighboring islands. Although freshwater fishes occur on parcels of ANP outside of MDI (Stone et al. 2001), only Park property and surrounding areas on MDI were sampled during the 2009 survey. Approximately 20% of ANP is classified as wetlands, which includes streams, lakes, marshes, ephemeral pools, bogs, and swamps (Calhoun et al. 1994). The Park also contains significant marine ecosystems, including estuaries, intertidal salt marshes, mud flats, and marine aquatic beds (Bank et al. 2006). Because the tidal range can be up to 3 m, the intertidal zone where some streams empty into the ocean encompasses a large area of ANP. Finally, there are many high-gradient streams in ANP due to the mountainous terrain of MDI.

Figure 1 (opposite page). Map of Mount Desert Island (44°21'N, 68°13'W). Lands belonging to Acadia National Park are stippled, private lands are unshaded, lakes/ponds are shaded, and the filled circles and numbers indicate streams sampled during the 2009 survey as follows: 1 = Northeast Creek, 2 = Old Mill, 3 = Stony, 4 = Breakneck, 5 = Witch Hole, 6 = Duck, 7 = Cromwell, 8 = Kebo, 9 = Bear, 10 = Meadow, 11 = Schooner Head, 12 = Sand Beach, 13 = Canon, 14 = Little Hunters, 15 = Hunters, 16 = Stanley, 17 = Jordan, 18 = Little Harbor, 19 = N.E. Trib. Hadlock, 20 = Hadlock Pond Connector, 21 = Jordan Feeder, 22 = S. Trib. Eagle Lake, 23 = Bubble, 24 = Brown, 25 = Southwest, 26 = Heath (east), 27 = Richardson, 28 = S. Aunt Betty Trib., 29 = E. Aunt Betty Trib., 30 = Babson, 31 = Round/Long Pond Connector, 32 = N. Hogdgon Trib., 33 = Hogdgon/Seal Cove Pond Connector, 34 = Duck Pond, 35 = Great, 36 = Seal Cove Outlet, 37 = Marshall, 38 = Lurvey, 39 = Heath (west), 40 = Adams, 41 = Seawall, 42 = Great Heath, 43 = Otter Creek. Inset shows the location of Mount Desert Island (outlined by a rectangle) in relation to Maine. Maps were created using ArcGIS 9.3.1 and iGMT 1.2.

Methods

Streams were prioritized prior to sampling to maximize the diversity of habitats and species sampled (Table 1). High priority streams were longer, more varied, and had more hydrogeologic features (e.g., gradients, coastal mouths) than low priority streams. Streams that were not sampled or insufficiently sampled during the 1998 and 1999 surveys (Moring et al. 2001) were also given high priority. Streams located primarily on Park lands were given priority over those located on adjacent private lands. High priority streams were sampled multiple times along their entire lengths using multiple techniques. Low priority streams were sampled less comprehensively. Based on these criteria, 9 streams were identified as high

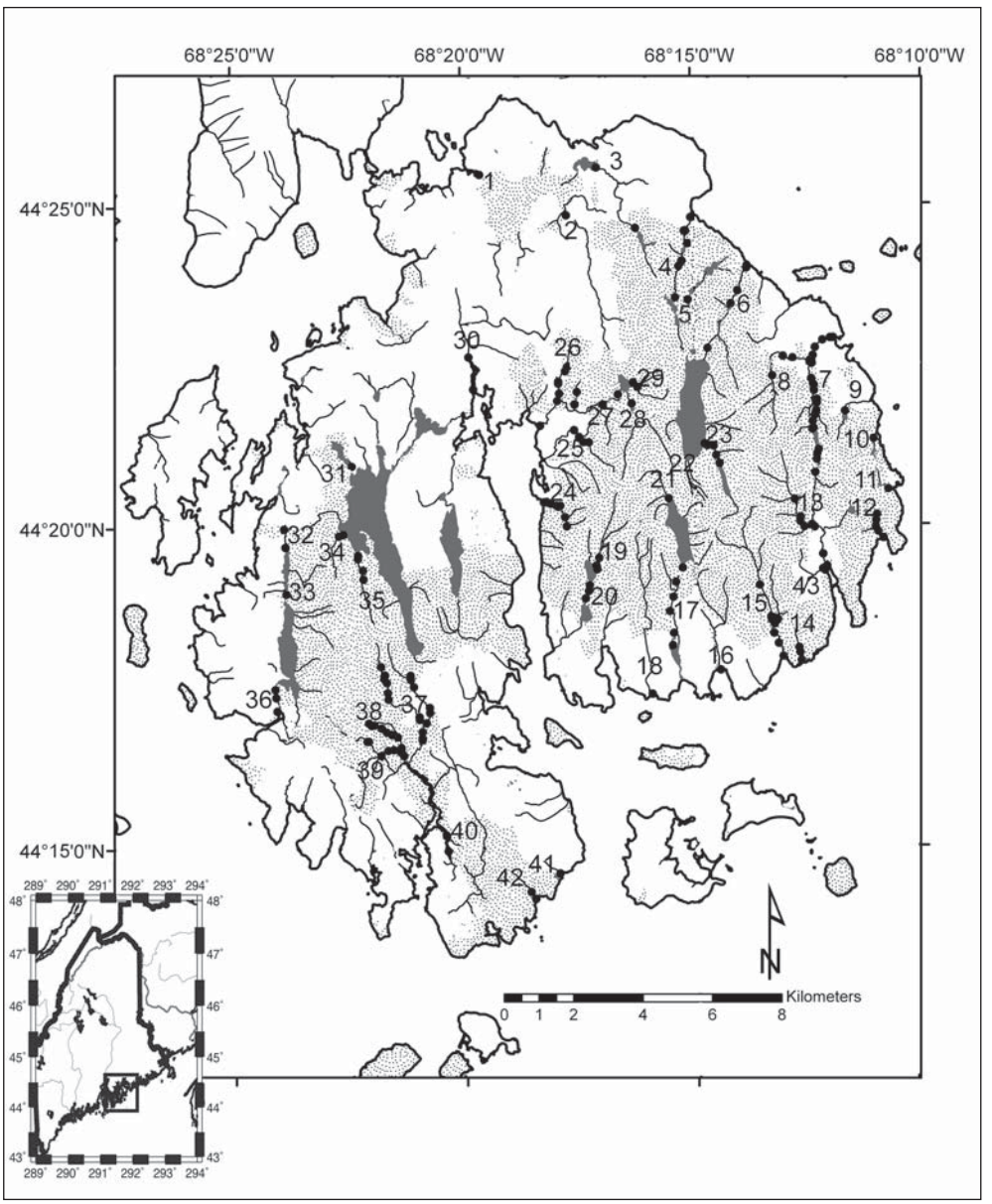

Table 1. Streams (n = 43) sampled in the 2009 survey of Acadia National Park. Stream = name of the stream (Round/Long Pond and Seal Cove/Hogdgon Pond refer to connector streams between ponds); Length = approximate length of the stream estimated from GIS data; Species = number of species collected; Coverage = Proportion of the stream that was sampled; Habitats = approximate number of unique habitats found in the sampled area of the stream based on visual observations during the survey; Method = collection technique(s) used in the stream: S = seining, T = minnow trapping, E = electrofishing.

Stream	Length (km)	Species	Coverage	Habitats	Method
Adams	2.0	2	Partial	1	S, T
Babson	3.0	2	Two points[A]	2	T
Bear	1.0	2	One point[A]	1	T
Breakneck	3.0	6	Complete	5	S, E, T
Brown	1.0	2	Complete[B]	3	S, E
Bubble	1.0	6	Complete	4	S, T
Canon	3.5	6	Complete[B]	6	S
Cromwell	3.5	10	Complete	9	S, T
Duck	3.9	10	Partial	7	S, T
Duck Pond	1.5	2	Partial	2	S
E. Trib. Aunt Betty	1.0	3	Partial	2	S, T
Great	2.0	3	Partial	3	S
Great Heath	0.5	1	Complete[B]	2	S
Hadlock Connect.	0.5	6	Complete	3	S, T
Heath (east)	1.8	2	Complete	4	S, E, T
Heath (west)	2.3	5	Complete	3	S
Hunters	3.0	1	Complete[B]	2	S
Jordan	2.5	6	Complete	4	S, E
Jordan Feeder	0.8	4	Two points[A]	2	T
Kebo	2.5	1	Complete	3	S
Little Harbor	1.0	2	Two points[A]	2	T
Little Hunters	1.0	0	Complete[B]	4	S
Lurvey	1.7	3	Complete	3	S
Marshall	3.7	6	Complete[B]	6	S
Meadow	0.5	0	One Point[A]	1	T
N. Trib. Hogdgon	0.6	2	Complete[B]	2	S
N.E. Trib. Hadlock	0.5	4	Partial	3	S
Northeast Creek	3.0	4	One Point[A]	1	T
Old Mill	3.0	0	One Point[A]	1	T
Otter Creek	0.8	5	Partial	3	S
Richardson	3.5	8	Complete	6	S, T
Round/Long Pond	0.3	0	One Point	1	T
S. Trib. Aunt Betty	0.9	3	Complete	3	S
S. Trib. Eagle Lake	0.5	1	One Point[A]	1	–[C]
Sand Beach	1.0	5	Complete	4	S, T
Schooner Head	1.0	1	One Point[A]	1	T
Seal Cove Outlet	1.5	7	Complete	4	S
Seal Cove/Hogdgon Pond	0.2	3	Complete	3	S, T
Seawall	0.5	1	One Point[A]	1	T
Southwest	3.0	1	Partial	4	S
Stanley	4.0	1	One Point[A]	1	T
Stony	2.5	2	Two points	2	T
Witch Hole	1.0	3	Complete	3	S

[A]Indicates streams that were surveyed in only 1 or 2 sample sites using minnow traps.
[B]Indicates streams that were sampled nearly completely.
[C]Brook Trout were only observed, not captured, in the S. tributary of Eagle Lake.

priority, 15 were given medium priority, and 12 were given low priority. Seven streams that were not initially identified as candidates were also sampled.

Fishes were primarily collected using seines and minnow traps during the 2009 survey (Table 1). Seining (1.22 m [4 ft] x 3.05 m [10 ft] seine with 0.3-cm [1/8-in] mesh) was performed with two or three people by dragging the seine through the water column and substrate or holding the seine in place and kicking through vegetation into it. Minnow traps were also used frequently in areas with heavy vegetation and minimal flow. Minnow traps were generally baited and deployed in sets of four traps, encompassing a radius of ≈6 m per set, for ≈24 hours. Seining and minnow traps were chosen as the primary collection methods because they were seldom used in streams during the 1998 and 1999 surveys (Moring et al. 2001), which primarily used backpack electrofishing units to sample streams. As a comparison, electrofishing was performed in 4 streams in 2009 that were also surveyed via seining (Table 1). Electrofishing produced mainly American Eel and Brook Trout, the most common species found in streams during the 1998 and 1999 surveys, while seining produced these species and additional, smaller species (Table 1). Seining and electrofishing often produce different estimates of species richness and abundance (Jurajda et al. 2009, Lapointe et al. 2006, Mercado-Silva and Escandón-Sandoval 2008). Because seining resulted in greater numbers of species, it was used throughout the survey, while electrofishing was abandoned. During seining and minnow trapping, visual surveys were performed to roughly estimate how many different habitat types (Table 1) were sampled in each stream. Habitats were classified based on visual observations of substrate, flow velocity, instream and riparian vegetation, water clarity, and apparent influence from lakes, ponds, and saltwater bodies.

Voucher specimens and tissue samples were collected and preserved from all species. Species were identified in the field according to Page and Burr (1991), and vouchers were later used by experts to confirm field identifications. Vouchers (n = 312) were preserved in 10% formalin and are housed jointly at ANP Headquarters (catalog numbers 21193–21259) and the Florida Museum of Natural History (FLMNH, Gainesville, FL; catalog numbers 174807–174959). Fin clips or whole juvenile fishes (n = 168) from some voucher specimens were preserved in 95% ethanol and are housed in the Genetic Resource Repository at the FLMNH (vial numbers 2009-0121 to 2009-0288). These tissues represent the first genetic resource available for most non-game ANP freshwater fishes, and the vouchers comprise the first comprehensive collection of fishes from ANP streams.

Results

From 3 June to 28 July 2009, 43 streams were sampled in ANP and adjacent private lands on MDI (Fig.1, Table 1). Fishes were collected in 39 streams (91%), although 8 streams (19%) had only a single species. Cromwell Brook and Duck Brook had the greatest species richness of ANP streams, with 10 species found in each stream. Little Hunters Brook was the only thoroughly sampled stream with abundant fish habitat where no fishes were captured. In general, longer streams with more varied habitats harbored greater species diversity.

Nineteen fish species were caught during the 2009 survey (Table 2). *Notemigonus crysoleucas* (Golden Shiner) was the most widely distributed species in ANP streams and was captured in 47% of the streams sampled. Brook Trout, American Eel, and *Pungitius pungitius* (Ninespine Stickleback) were widely distributed and were captured at more than 35% of sampling locations. Several species were caught in coastal areas of only a few streams: *Menidia menidia* (Atlantic Silverside; 2% of sampled streams), *Trachurus lathami* (Rough Scad; 2%), and *Myoxocephalus aenaeus* (Grubby; 2%). A few freshwater species were also rare: *Ameiurus melas* (Black Bullhead; 2%), Fathead Minnow (5%), *Esox americanus americanus* (Redfin Pickerel; 7%), and *Perca flavescens* (Yellow Perch; 7%). The rarest species was Black Bullhead,

Table 2. Freshwater fish species found in the 2009 survey of 43 streams in Acadia National Park (ANP). Native = native or non-native based on Stone et al. (2001) and Page and Burr (1991); # = number of streams from which the species was collected; 1998/9? = whether or not the species was captured during the stream surveys in 1998 and 1999.

Common name	Scientific name	Native	#	1998/9?
Anguillidae				
American Eel	*Anguilla rostrata* (Lesueur)	Yes	17	Yes
Cyprinidae		Yes	11	No
Northern Redbelly Dace	*Phoxinus eos* (Cope)	No	5	Yes
Common Shiner	*Luxilus cornutus* (Mitchill)	Yes	20	Yes
Golden Shiner	*Notemigonus crysoleucas* (Mitchill)	No	2	No
Fathead Minnow	*Pimephales promelas* Rafinesque			
Catostomidae				
White Sucker	*Catostomus commersonii* (Lacepède)	Yes	4	Yes
Ictaluridae				
Black Bullhead	*Ameiurus melas* (Rafinesque)	No	1	No
Esocidae				
Redfin Pickerel	*Esox americanus americanus* Gmelin	No	3	No
Salmonidae				
Brook Trout[A]	*Salvelinus fontinalis* (Mitchill)	Yes	19	Yes
Cottidae				
Grubby[B]	*Myoxocephalus aenaeus* (Mitchill)	Yes	1	No
Cyprinodontidae				
Banded Killifish	*Fundulus diaphanus* (Lesueur)	Yes	8	Yes
Mummichog	*Fundulus heteroclitus* L.	Yes	7	Yes
Atherinidae				
Atlantic Silverside[B]	*Menidia menidia* L.	Yes	1	No
Gasterosteidae				
Fourspine Stickleback	*Apeltes quadracus* Mitchill	Yes	2	Yes
Threespine Stickleback	*Gasterosteus aculeatus* L.	Yes	8	Yes
Ninespine Stickleback	*Pungitius pungitius* L.	Yes	16	Yes
Carangidae				
Rough Scad	*Trachurus lathami* Nichols	Yes	2	No
Centrarchidae				
Pumpkinseed	*Lepomis gibbosus* L.	Yes	10	Yes
Percidae				
Yellow Perch	*Perca flavescens* Mitchill	No	3	Yes

[A]One probable sea-run Brook Trout was collected from Jordan Brook (see Discussion)
[B]Collected from coastal areas of a single brook

with only one individual caught during the 2009 survey. Smaller species were generally caught in the highest numbers. For example, more than 100 individuals of *Fundulus heteroclitus* (Mummichog) were regularly collected in a single seining attempt at Sand Beach Brook.

Discussion

There were 104 instances where species found in a particular stream during the 2009 survey were not collected from the same stream during the 1998 and 1999 surveys, and 10 instances where species collected in the 1998 and 1999 surveys were not found in the 2009 survey (Table 3). Additionally, Fathead Minnow, Rough Scad, Black Bullhead, Redfin Pickerel, and Grubby were collected from ANP streams for the first time. This increased diversity can be partially explained by the use of seining instead of electrofishing during the 2009 survey, which tended to capture smaller species that were missed earlier. For example, American Eel and Brook Trout were the only species previously identified in Heath Brook (on west MDI, not to be confused with a stream of the same name on east MDI), but seining this stream in 2009 resulted in 4 other species that were undetected previously: Ninespine Stickleback, *Chrosomus eos* (Northern Redbelly Dace), *Luxilus cornutus* (Common Shiner), and Golden Shiner. Other explanations for the increased diversity collected in 2009 include sampling more streams, sampling streams more thoroughly, sampling more habitats within streams, and sampling more coastal areas of streams (explaining the collection of Grubby and Rough Scad). For example, Otter Creek empties into Otter Cove, and a clear demarcation (a ≈2 m waterfall) exists during low tide where the stream ends and the ocean begins. However, the barrier is submerged and the stream gradually widens into the cove during high tide. Therefore, sampling at the mouth of this stream produced marine species that would generally not be found in an inland stream habitat and were not found in the previous surveys. Correcting earlier misidentifications via vouchers was also possible for some species. For example, *Esox niger* Lesueur (Chain Pickerel) was previously reported from ANP streams (Stone et al. 2001); however, examination of branchiostegal rays on vouchers collected during the 2009 survey from the same streams revealed that these records were likely Redfin Pickerel and were probably misidentified in the field as Chain Pickerel.

Fathead Minnows were recorded from ANP and MDI for the first time during the 2009 survey. They are likely the most recent bait-bucket introduction to ANP because Fathead Minnows are popular baitfish and anglers are known to transfer baitfish to ANP regularly (Bowes et al. 1999, Stone et al. 2001). Although only one individual was captured at Bubble Brook, many (totaling more than 100 individuals) were captured at Cromwell Brook, particularly near the Park Loop Road crossing. This finding suggests a single bait-bucket introduction in Cromwell Brook is responsible for Fathead Minnows in ANP and MDI and that they may be spreading to other streams. Because Cromwell Brook was not sampled during the 1998 and 1999 surveys, it is unclear whether the introduction occurred since then. Similarly, although other bait species are classified as native (e.g., Golden

Table 3. Species found in individual streams during the 2009 survey and in the same streams during the 1998 and 1999 surveys. Abbreviations for species: AE = American Eel, AP = Redfin Pickerel, AS = Atlantic Silverside, BB = Black Bullhead, BK = Banded Killifish, BT = Brook Trout, CC = *Semotilus atromaculatus* Mitchell (Creek Chub), CP = Chain Pickerel, CS = Common Shiner, FM = Fathead Minnow, GS = Golden Shiner, MM = Mummichog, ND = Northern Redbelly Dace, PK = Pumpkinseed, RS = Rough Scad, SC = Grubby, WS = White Sucker, YP = Yellow Perch, 3S = Threespine Stickleback, 4S = Fourspine Stickleback, 9S = Ninespine Stickleback, ?? = Unidentified species.

Stream	2009 species	1998/1999 species
Adams	MM, 9S	AE, MM, 4S
Babson	AE, SC	Not sampled
Bear	GS, PK	CC, GS
Breakneck	AE, BK, BT, ND, PK, 9S	AE, BT, PK
Brown	AE, BT	Not sampled
Bubble	AE, BK, CS, FM, ND, PK	AE, BT, CS
Canon	AE, BT, GS, MM, RS, 9S	Not sampled
Cromwell	AE, BB, BK, BT, FM, GS, ND, PK, 3S, 9S	Not sampled
Duck	AE, BK, BT, CS, GS, ND, PK, 3S, 9S, ??	AE, BK, BT, CS
Duck Pond	AP, GS	None
E. Trib. Aunt Betty	GS, WS, 9S	AE, GS, WS, 3S
Great	AP, BT, WS	BT, WS
Great Heath	AE	Not sampled
Hadlock Connect.	BK, BT, CS, GS, ND, PK	BK, BT, PK
Heath (east)	BT, ND	Not sampled
Heath (west)	BT, CS, GS, ND, 9S	AE, BT
Hunters	BT	AE, BT
Jordan	AE, BK, BT, GS, ND, 9S	Not sampled
Jordan Feeder	AE, CS, GS, PK	Not sampled
Kebo	BT	Not sampled
Little Harbor	AE, MM	AE, BK, BT
Little Hunters	None	Not sampled
Lurvey	BT, GS, 9S	BT, 9S
Marshall	AE, BT, GS, ND, 3S, 9S	AE, BT, 9S
Meadow	None	Not sampled
N. Trib. Hogdgon	GS, YP	Not sampled
N.E. Trib. Hadlock	BK, BT, ND, PK	BK, BT, PK
Northeast Creek	AE, MM, 3S, 4S	Not sampled
Old Mill	None	Not sampled
Otter Creek	AE, BT, RS, 3S, 9S	Not sampled
Richardson	AE, BK, BT, GS, MM, WS, 3S, 9S	AE, BT, WS
Round/Long P.	None	Not sampled
S. Trib. Aunt Betty	GS, WS, 9S	GS, WS, 9S
S. Trib. Eagle Lake	BT	Not sampled
Sand Beach	AE, AS, MM, 3S, 9S	Not sampled
Schooner Head	GS	Not sampled
Seal Cove Outlet	AE, GS, MM, PK, YP, 3S, 4S	CP
Seal Cove/Hogdgon P.	AP, GS, YP	AE, BB, CP, YP
Seawall	GS	None
Southwest	GS	Not sampled
Stanley	BT	AE, BT
Stony	AE, PK	Not sampled
Witch Hole	GS, ND, 9S	Not sampled

Shiners), their wide distributions in ANP may be due to bait-bucket transfers and not due to naturally large ranges (Batchelder 1927, Bowes et al. 1999).

Northern Redbelly Dace were abundant in the 2009 survey, but were not collected from any streams during the 1998 and 1999 surveys (Moring et al. 2001). Northern Redbelly Dace were previously documented from only one ANP stream (Marshall Brook; Bowes et al. 1999, Doering et al. 1995), but are known from several ANP ponds (Burgess 1995, Davis 1958, Stone et al. 2001). In 2009, Northern Redbelly Dace were frequently collected (11 of 43 streams) from middle stretches of streams and were likely not transients from ponds. The abundance of Northern Redbelly Dace in 2009 may have been due to sampling with seines instead of electrofishing or indicative of range expansion, due to either natural migration or bait-bucket transfers.

Brook Trout is one of the most popular sport fish in ANP streams. The 2009 survey noted Brook Trout in 19 ANP streams, and populations in Jordan and Kebo Brooks especially warrant further study based on the 2009 survey. Based on its appearance and size, one probable sea-run Brook Trout was captured from Jordan Brook in the 2009 survey, and a sea-run Brook Trout was previously collected from Little Long Pond (Moring et al. 2001). Because Little Long Pond connects Jordan Brook to the ocean, these two captures suggest that the Jordan Brook/Little Long Pond system may have a population of sea-run Brook Trout. Sea-run (anadromous) Brook Trout undergo a distinct life-history strategy by migrating downstream to feed in the sea during the spring and returning back up the streams during mid-late summer (Morinville and Rasmussen 2003). Compared to other Brook Trout, these MDI trout are usually bigger and can have silver coloration (B. Connery, pers. observ.). Sea-run Brook Trout populations are declining and disappearing across the northeastern US and eastern Canada (Doucett et al. 1999, Ryther 1997), and populations on MDI also appear to have undergone drastic declines and extirpations based on anecdotal evidence of historical (as late as the 1970s) stream populations and abundances from MDI anglers (B. Connery, pers. observ.). An unpublished pilot study conducted in 2007 that targeted sea-run Brook Trout from four coastal ANP streams (Stanley, Little Harbor, Hunter, and Little Long Pond/Jordan) failed to capture any conspicuous sea-run Brook Trout (Sougniey et al. 2007), and they were reported only twice in documented ANP surveys (Moring et al. 2001), further suggesting local declines since historical times. Therefore, the identification of a possible sea-run Brook Trout population in the Jordan Brook/Little Long Pond system or other streams on MDI warrants further investigation. Results of these investigations may encourage and inform restoration programs and cause immediate protective action through recreational angling management activities such as changing harvestable sizes, altering harvesting seasons for coastal streams, or closing sensitive sections of ANP. Because ponds and streams in ANP are managed by different agencies (MDIFW and NPS), any attempts to study or manage sea-run Brook Trout in ANP will have to be a cooperative effort.

Brook Trout in Kebo Brook were collected and observed in greater numbers than in any other ANP stream during the 2009 survey. However, the lower section

of this stream was one of the most human-impacted streams surveyed during 2009 because it flows through the Kebo Golf Course and the southern edge of the town of Bar Harbor. It is unclear why this stream has such a large abundance of Brook Trout. These findings represent numerous research, management, and educational opportunities where the Park and state agencies can work with residents and visitors to encourage natural resource appreciation and protection. Interactive programs such as trout watching, recreational angling, and catch-and-release days encourage resource stewardship in protecting and wisely using all stream systems. The lower section of Kebo Brook is ideal for these activities due to its easy accessibility and large abundance of Brook Trout.

As noted by Moring et al. (2001), the streams of ANP have not been directly stocked with fishes and are therefore relatively pristine compared to the regularly stocked and managed lakes and ponds of ANP. However, 5 of the 19 species collected during the 2009 survey are not native to MDI streams (Page and Burr 1991, Stone et al. 2001), and many bait species used for fishing in ANP ponds may have escaped to streams or been transported there directly through bait-bucket transfers and are altering natural stream communities. The fish assemblages found in ANP streams are typical of other small coldwater streams and rivers in the northeast US (Langdon 2001, Yoder and Hersha 2008). Many of the species collected are members of desirable fish communities targeted during river restoration in Maine (Bain and Meixler 2008). Brook Trout density and size class structure have been used as indicators of biological integrity for small coldwater streams in Vermont (Langdon 2001). High densities of both adult and young-of-the-year Brook Trout collected in many ANP streams (Table 3) during 2009 suggest some streams on ANP have high biotic integrity. Other streams had high proportions of species that are warm-tolerant and generalist feeders (e.g., Northern Redbelly Dace, Fathead Minnow), suggesting lower biotic integrity (Langdon 2001).

This study provides an updated, more complete baseline of fishes occurring in ANP streams. The large increase in species found in individual streams compared to the last Park-wide surveys in 1998 and 1999 demonstrates the need to use multiple types of collection gear and continue surveys on a regular basis. ANP officials are greatly concerned with measuring and reversing habitat degradation in ANP due to inappropriate land-use practices, road crossings, pollution, angling influence, and other anthropogenic effects. However, remediation efforts cannot be properly targeted and their effects cannot be assessed without a rudimentary understanding of the distribution and abundances of species. This study identified several streams as candidates for restoration, management, or focused monitoring. For example, the lower stretches of Cromwell Brook (near the town of Bar Harbor) have been reinforced with concrete blocks, causing destruction of undercut banks and increasing flow, which has in turn reduced Brook Trout abundance. Another notable example is the eastern tributary of Marshall Brook, which contained no fish and appears drastically altered due to an adjacent landfill, development, and road-crossing barriers (Bowes et al. 1999, Boyle et al. 1987, Doering et al. 1995). One of the main concerns to ANP streams identified by this study is the transfer and introduction of baitfish, as evidenced by the discovery

of Fathead Minnows. Signage near stream road-crossings urging anglers not to release bait into streams and increased monitoring of stream anglers may help prevent further spread of these species. Finally, because many ANP streams flow through private lands at some point in their course, ANP must involve landowners in all efforts to restore, manage, and conserve fishes and their habitats.

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