

The Canadian Field-Naturalist

SUPPLEMENTARY MATERIAL:

Banded Killifish (*Fundulus diaphanus*) and Mummichog (*Fundulus heteroclitus*) distributions in insular Newfoundland waters: implications for a Species at Risk

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TABLE S1. List of museum collection records of Banded Killifish (*Fundulus diaphanus*), Mummichog (*Fundulus heteroclitus*), and potential hybrids (*Fundulus* sp.) from insular Newfoundland. Note: The order of specimens follows the Newfoundland coastline counterclockwise, starting on the northern peninsula and ending on the northeast coast.

Species name	Collection site	Latitude	Longitude	Collection* catalog no.	Record period (This study/ Previous)
<i>F. diaphanus</i>	Grand Pond, Plum Point	51.08734°N	56.86154°W	NFM PI-57	This study
<i>F. diaphanus</i>	Little Brook Pond, near River of Ponds	50.55356°N	57.37507°W	NFM PI-91	This study
<i>F. diaphanus</i>	Cow Head Pond	49.90396°N	57.77584°W	NFM PI-94	This study
<i>F. diaphanus</i>	Manuals, Goose Arm, Bay of Islands	49.11147°N	57.96042°W	NFM PI-117	This study
<i>F. heteroclitus</i>	York Harbour, Bay of Islands	49.05713°N	58.37069°W	NFM PI-74, NFM PI-109, & NFM PI-110	This study
<i>F. diaphanus</i>	Small brook entering Pinchgut Lake	48.80192°N	58.01081°W	NFM PI-69	This study
<i>F. diaphanus</i>	Georges Lake	48.77167°N	58.14290°W	NFM PI-93	This study
<i>F. diaphanus</i>	Moose Pond, near Gallants	48.67648°N	58.21127°W	NFM PI-90	This study
<i>F. diaphanus</i>	First Pond, off South West Brook	48.52246°N	58.24964°W	NFM PI-92	This study
<i>F. diaphanus</i>	Noel's Pond, Stephenville	48.55762°N	58.53517°W	ROM 23373†	Previous
<i>F. heteroclitus</i>	Point au Mal	48.65851°N	58.67549°W	NFM PI-100	This study
<i>F. heteroclitus</i>	Point au Mal	48.64898°N	58.65308°W	NFM PI-101	This study
<i>F. diaphanus</i>	Gravels Pond, near Port au Port	48.55833°N‡	58.53333°W‡	CMNFI 1966-0140	Previous
<i>F. heteroclitus</i>	Piccadilly	48.55561°N§	58.90506°W§	ROM 20986	Previous
<i>F. heteroclitus</i>	Piccadilly	48.87000°N‡	58.92000°W‡	CMNFI 1958-0309.1	Previous
<i>F. heteroclitus</i>	Harrys Brook, West Bay Centre	48.61000°N‡	58.97000°W‡	CMNFI 1966-0131.3	Previous
<i>F. heteroclitus</i>	Harrys Brook, West Bay Centre	48.60397°N	58.96172°W	NFM PI-108	This study
<i>F. heteroclitus</i>	Victor's Brook, Port au Port Bay	48.63000°N‡	58.97000°W‡	CMNFI 1966-0130.2	Previous
<i>F. heteroclitus</i>	Victor's Brook, Port au Port Bay	48.62866°N	58.97356°W	NFM PI-107	This study
<i>F. diaphanus</i>	Seal Cove Brook, Stephenville Crossing	48.51564°N§	58.45851°W§	ROM 21979†	Previous
<i>F. heteroclitus</i>	Seal Cove Brook, Stephenville Crossing	48.51564°N	58.45851°W	ROM 0355CS & ROM 20991	Previous
<i>F. diaphanus</i>	Stephenville Crossing	48.5000°N	58.43333°W	ARC 22887†	Previous
<i>F. diaphanus</i>	Stephenville Crossing	48.5000°N§	58.43333°W§	ARC 22889†	Previous
<i>F. heteroclitus</i>	Stephenville Crossing	48.50513°N	58.43469°W	NFM PI-80	This study
<i>F. diaphanus</i>	Unnamed pond south of Stephenville Crossing	48.48319°N	58.41958°W	NFM PI-55	This study
<i>F. heteroclitus</i>	Unnamed pond south of Stephenville Crossing	48.48319°N	58.41958°W	ARC 29985	This study
<i>F. diaphanus</i>	Barachois Pond	48.48275°N	58.26319°W	NFM PI-119 & NFM PI-120	This study

TABLE S1. Continued.

Species name	Collection site	Latitude	Longitude	Collection* catalog no.	Record period (This study/ Previous)
<i>F. diaphanus</i>	Goose Pond	48.42025°N	58.43318°W	NFM PI-53	This study
<i>F. diaphanus</i>	Duck Pond	48.38556°N	58.46965°W	NFM PI-54	This study
<i>F. diaphanus</i>	Highlands River	48.17364°N	58.87308°W	ARC 29977	This study
<i>F. heteroclitus</i>	Muddy Hole, Doyles	47.83291°N	59.21269°W	NFM PI-105	This study
<i>F. heteroclitus</i>	Grand Codroy River, near Searston	47.83000°N‡	59.30000°W‡	CMNFI 1966-0200.3	Previous
<i>F. heteroclitus</i>	McIssac's Island, Little Codroy Valley	47.77657°N§	59.266719°W§	ROM 21049	Previous
<i>F. heteroclitus</i>	Small island below salmon fence, Little Codroy River	47.76476°N§	59.31230°W§	ROM 21048	Previous
<i>F. heteroclitus</i>	Little Paradise Park, St. Andrew's	47.76192°N	59.28696°W	NFM PI-82	This study
<i>Fundulus</i> sp.	Little Paradise Park, St. Andrew's	47.76192°N	59.28696°W	ARC 29984	This study
<i>F. diaphanus</i>	Pond near Little Paradise Park, St. Andrew's	47.75678°N	59.27636°W	NFM PI-99	This study
<i>F. heteroclitus</i>	Pond near Little Paradise Park, St. Andrew's	47.75678°N	59.27636°W	NFM PI-106	This study
<i>F. heteroclitus</i>	Saltwater Pond, Grand Bay West	47.59232°N	59.20138°W	NFM PI-77	This study
<i>Fundulus</i> sp.	Saltwater Pond, Grand Bay West	47.59232°N	59.20138°W	ARC 29983	This study
<i>F. heteroclitus</i>	Second Pond, Grand Bay West	47.58991°N	59.19709°W	ARC 29982	This study
<i>F. heteroclitus</i>	First Pond, Grand Bay West	47.58673°N	59.19177°W	ARC 29978	This study
<i>F. heteroclitus</i>	First Pond, Grand Bay West	47.58746°N	59.19128°W	ARC 29979	This study
<i>F. heteroclitus</i>	First Pond, Grand Bay West	47.58746°N	59.19128°W	NFM PI-76	This study
<i>F. heteroclitus</i>	Grand Bay Pond, Grand Bay West	47.59269°N	59.18959°W	NFM PI-102	This study
<i>F. diaphanus</i>	Ramea Island	47.51776°N§	57.40076°W§	NFM PI-50† & NFM PI-51	Previous
<i>F. diaphanus</i>	Terrenceville River	47.67688°N	54.69262°W	NFM PI-98	This study
<i>F. heteroclitus</i>	Terrenceville River	47.67508°N§	54.70687°W§	ROM 23372	Previous
<i>F. diaphanus</i>	Garnish Pond	47.20864°N	55.21651°W	NFM PI-56	This study
<i>F. diaphanus</i>	Big Hill Pond	47.20429°N	55.34087°W	NFM PI-62	This study
<i>F. diaphanus</i>	Frenchman's Cove Barasway	47.20799°N	55.39604°W	NFM PI-52	This study
<i>F. diaphanus</i>	Little Barasway, Molliers	47.10516°N	55.62617°W	NFM PI-66	This study
<i>F. diaphanus</i>	L'Anse au Loup Country Pond	47.08486°N	55.66400°W	NFM PI-71	This study
<i>F. diaphanus</i>	Country Pond, Grand Bank	47.09096°N	55.73082°W	NFM PI-60	This study
<i>F. diaphanus</i>	Admiral Cove Pond, Grand Bank	47.10172°N	55.76700°W	NFM PI-59	This study
<i>F. diaphanus</i>	"Little" Rocky Pond	46.86873°N	55.83189°W	NFM PI-65	This study
<i>F. diaphanus</i>	Frenchman's Pond, Point au Gaul	46.86739°N	55.75476°W	NFM PI-68	This study
<i>F. diaphanus</i>	Burin	47.01667°N	55.18333°W	ARC 22888	Previous
<i>F. diaphanus</i>	Salt Pond, near Burin	47.10002°N	55.20096°W	NFM PI-72	This study
<i>F. diaphanus</i>	Landing Place Pond	47.13684°N	55.20202°W	NFM PI-61	This study
<i>F. diaphanus</i>	Bowes Pond, Marystown	47.15550°N	55.16702°W	NFM PI-58	This study
<i>F. diaphanus</i>	Janes Pond, Marystown	47.16626°N	55.16250°W	NFM PI-70	This study
<i>F. diaphanus</i>	Powers Pond, Marystown	47.18174°N	55.14651°W	NFM PI-67	This study
<i>F. diaphanus</i>	Burton's Pond, St. John's	47.57371°N	52.72822°W	NFM PI-63	This study
<i>F. diaphanus</i>	Quidi Vidi Lake, St. John's	47.58092°N	52.69009°W	NFM PI-64	This study
<i>F. diaphanus</i>	Deadman's Bay	49.32912°N	53.70200°W	NFM PI-97	This study
<i>F. diaphanus</i>	Deadman's Bay	49.34103°N	53.70748°W	NFM PI-95 & NFM PI-96	This study
<i>F. heteroclitus</i>	Saltwater Pond, Banting Memorial Municipal Park	49.41603°N	53.87861°W	NFM PI-116	This study

TABLE S1. *Continued.*

Species name	Collection site	Latitude	Longitude	Collection* catalog no.	Record period (This study/ Previous)
<i>F. heteroclitus</i>	Musgrave Harbour	49.44822°N	53.94281°W	NFM PI-115	This study
<i>F. heteroclitus</i>	Gander Bay	49.26369°N	54.51142°W	NFM PI-78	This study
<i>F. heteroclitus</i>	Dog Bay, near Horwood	49.42270°N	54.56790°W	NFM PI-79	This study
<i>F. heteroclitus</i>	East of Birchy Bay	49.37156°N	54.70251°W	NFM PI-114	This study
<i>F. heteroclitus</i>	Bottom Brook, Lewisporte	49.21744°N	55.04955°W	NFM PI-75 & NFM PI-104	This study
<i>F. heteroclitus</i>	Stanhope Brook, Stanhope	49.26961°N	55.07886°W	NFM PI-81	This study
<i>F. heteroclitus</i>	Norris Arm North	49.12852°N	55.19500°W	NFM PI-103	This study

*Collection codes: ARC = Atlantic Reference Centre (St. Andrew’s, NB); CMNFI = Canadian Museum of Nature (Ottawa, ON); NFM = The Rooms (St. John’s, NL); ROM = Royal Ontario Museum (Toronto, ON).

†Museum records reported in primary literature.

‡Site co-ordinates for this collection appear inaccurate based on the site description and were likely generalized.

§Site co-ordinates were not available for this collection and were estimated by P.S.S. based on available site descriptions.

|Site co-ordinates were not available for this collection and were estimated by museum personnel (L. van Guelpen pers. comm. 13 June 2014).

TABLE S2. Meristics and morphometrics of Banded Killifish (*Fundulus diaphanus*), Mummichog (*Fundulus heteroclitus*), and potential hybrids (*Fundulus* sp.), collected throughout insular Newfoundland (2013–2016). Data presented are mean values followed by ranges in brackets.

Species	Meristics			Morphometrics		
	# of scale rows*	# of gill rakers*	# of dorsal fin rays*	Dorsal fin index	Stepped forward location*	CD/DO–EV ratio
Banded Killifish (<i>n</i> = 128)	48 (42–55)	5 (4–7)	14 (12–15)	8 (4–16)	pupil of eye (between the eye and operculum to anterior of eye)	0.20 (0.15–0.25)
Mummichog (<i>n</i> = 115)	36 (32–39)	8 (6–10)	11 (10–14)	13 (8–26)	posterior operculum (posterior to the operculum to posterior to the eye)	0.33 (0.25–0.40)
Potential hybrid (<i>n</i> = 2)	42 (N/A)	7 (6–9)	12 (12–13)	13 (11–14)	mid-operculum (posterior operculum to anterior operculum)	0.25 (0.24–0.26)

Note: CD/DO–EV = the ratio of caudal depth to the distance from origin of dorsal fin to end of vertebrae.

*Characters used to differentiate Banded Killifish and Mummichog in the laboratory.

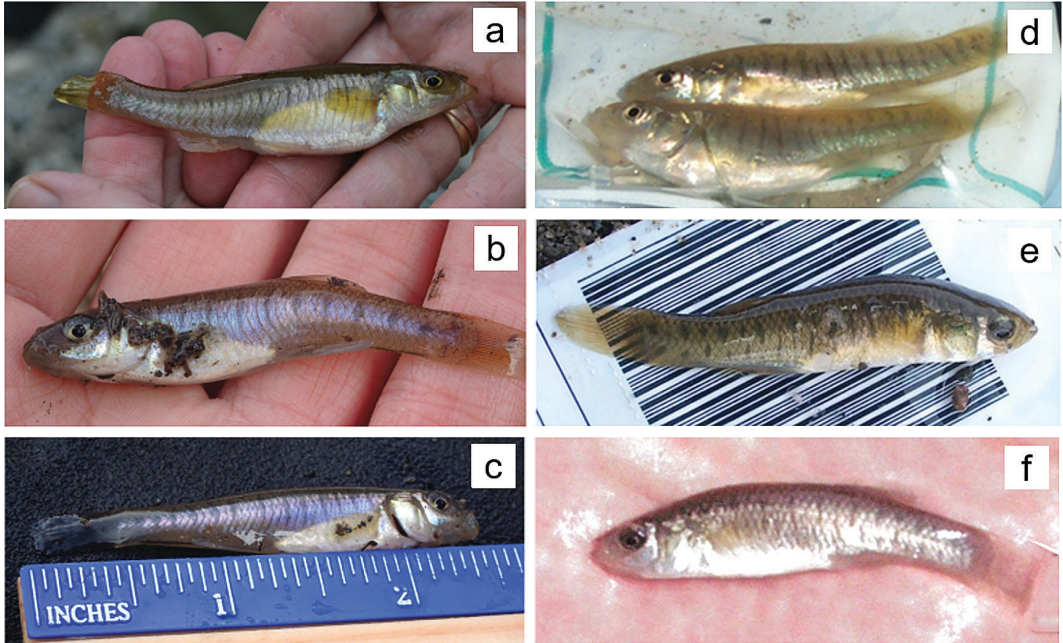


FIGURE S1. Photographs used to verify presence of Banded Killifish (*Fundulus diaphanus*) and Mummichog (*Fundulus heteroclitus*) in insular Newfoundland where physical specimens could not be acquired. a. Banded Killifish collected from Pinchgut Lake in 2013; b. and c. Banded Killifish collected from Wild Cove Brook in 2015; d. Mummichog from York Harbour in 2003; e. and f. Mummichog from York Harbour in 2006. Photo: a. Emma O'Melia (Clark University). Photos b–c. Greg Moore (ACAP Humber Arm). Photo d. Laura Park (Fisheries and Oceans Canada). Photos e–f. Derek Osborne.

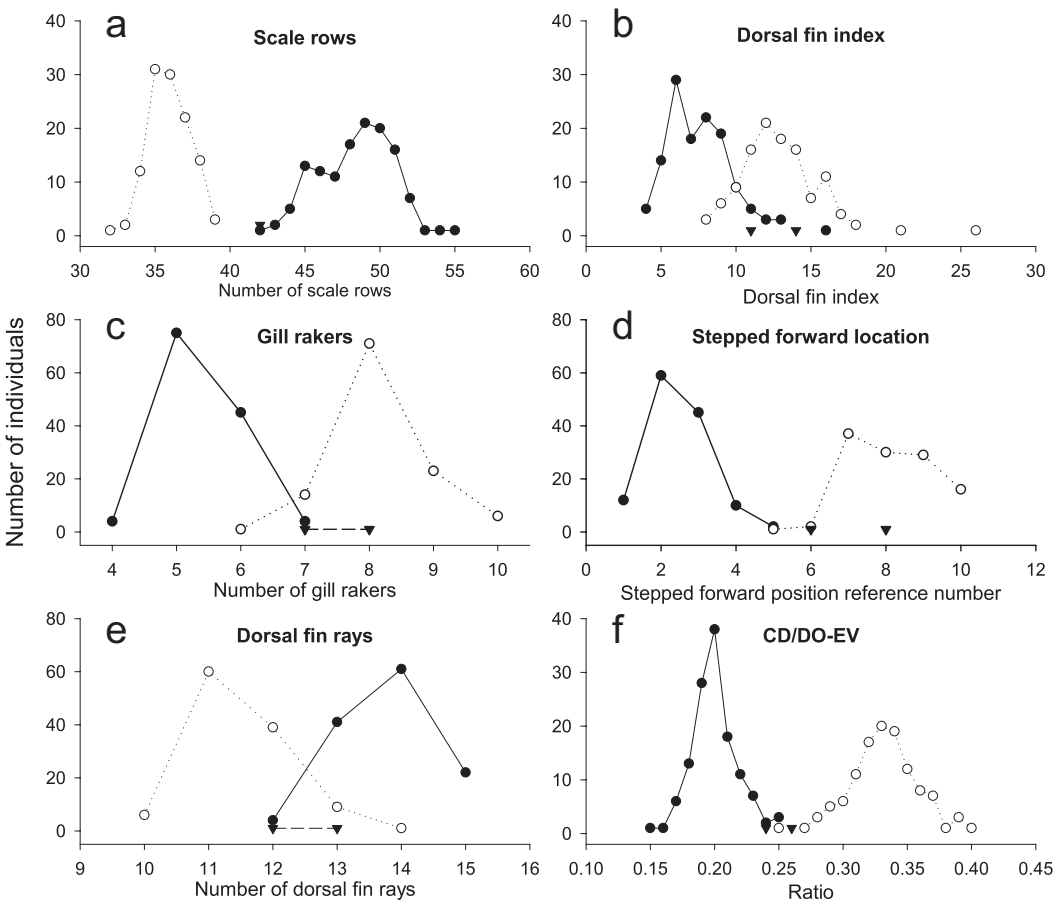


FIGURE S2. Frequency distributions comparing meristic and morphological characters of ● = Banded Killifish (*Fundulus diaphanus*), ○ = Mummichog (*Fundulus heteroclitus*), and ▼ = potential hybrids (*Fundulus* sp.) collected in insular Newfoundland (2013–2016). Note: CD/DO–EV = the ratio of caudal depth to the distance from origin of dorsal fin to end of vertebrae; Stepped forward position reference numbers are as follows: 1 = anterior eye; 2 = pupil; 3 = posterior eye; 4 = posterior to the eye; 5 = between the eye and the operculum; 6 = anterior operculum; 7 = mid-operculum; 8 = posterior operculum; 9 = posterior edge of operculum; 10 = posterior to the operculum.

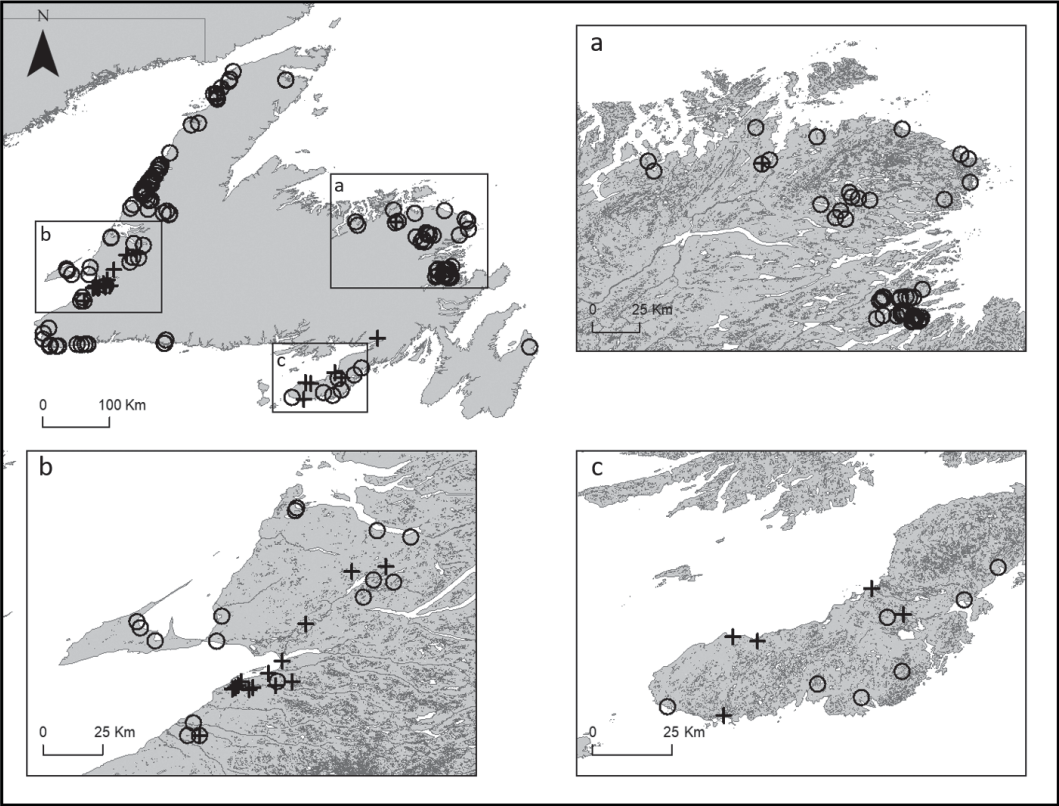


FIGURE S3. Locations where Banded Killifish (*Fundulus diaphanus*) were not detected in insular Newfoundland. ○ = locations where Banded Killifish were not detected during surveys in this study and grey literature, and unconfirmed (i.e., lacking physical evidence for species identification). + = potential locations for Banded Killifish (based on grey literature and local ecological knowledge).

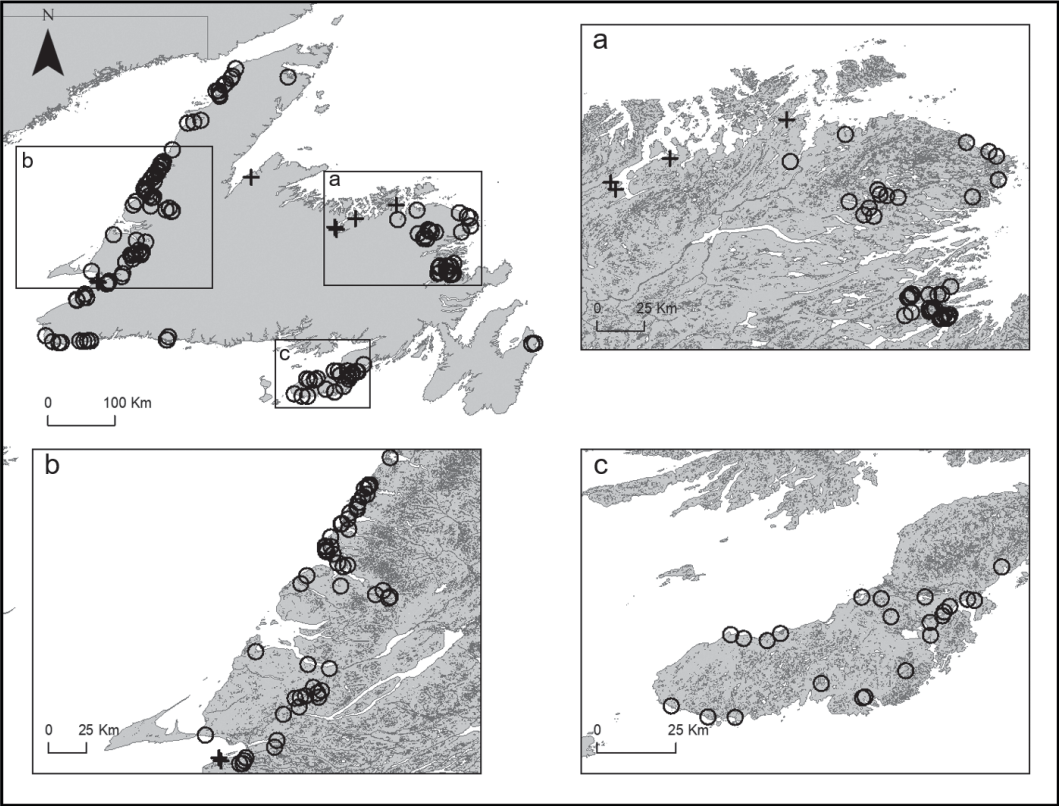


FIGURE S4. Locations where Mummichog (*Fundulus heteroclitus*) were not detected in insular Newfoundland. ○ = locations where Mummichog were not detected during surveys in this study and grey literature, and unconfirmed (i.e., lacking physical evidence for species identification). + = potential locations for Mummichog (based on grey literature and local ecological knowledge).