Summary of Maine Atlantic sturgeon data:

Description of monitoring 1977-2001 and 2009-2011
in the Kennebec and Merrymeeting Bay Estuary System

Prepared by Gail Wippelhauser, Ph. D.
Maine Department of Marine Resources
Division of Sea Run Fisheries
172 State House Station, Augusta, ME 04333

Atlantic sturgeon – 1977-2001 data summary

Introduction

Populations of Atlantic sturgeon and shortnose sturgeon currently inhabit the Kennebec complex in Maine, which encompasses the Kennebec River, Androscoggin River, Sheepscot River, Sasanoa River, Back River, Hockomock Bay, Montsweag Bay, and Knubble Bay (Figure 1). Freshwater from the Kennebec and Androscoggin, Maine' s second and third largest rivers, respectively, and three small tributaries, unite to form a large tidal-freshwater embayment (Merrymeeting Bay), below which the Kennebec become increasingly saline as it travels to the Gulf of Maine.

Commercial harvesting of sturgeon (species not distinguished) began early in the Kennebec complex, and continued for over 300 years. By 1673, the English had established a commercial fishing operation at Pejepscot Falls on the Androscoggin River, and caught ninety kegs of sturgeon in just three weeks (http://www.bethelhistorical.org/A_River's_Journey.html). Maine's Commissioners of Fisheries (1867) reported that "in 1849 a Mr. N.K. Lombard, representing a Boston firm, came down to the Kennebec... and undertook to put up the roe of sturgeon for caviar, and at the same time boil down the bodies for oil....The first year were obtained 160 tons of sturgeon". In the 1900s sturgeon were being processed near the outlet of Merrymeeting Bay (Figure 2). Atlantic sturgeon were still commercially harvested in the Kennebec complex in 1980 in a fishery that targeted spawning sturgeon. Sturgeon harvest was finally closed by DMR rule on November 9, 1983

Atlantic sturgeon have been taken as bycatch in five major scientific studies in the Kennebec complex that primarily targeted shortnose sturgeon. From 1977 to 1983, gillnet sampling and conventional Carlin tagging were used to determine the distribution and abundance of the shortnose sturgeon population. In 1993, acoustic telemetry and various types of net sampling were used to assess the potential impacts of a proposed bridge construction on shortnose sturgeon reproduction in the Androscoggin River. From 1996 through 1998, acoustic telemetry and gill net sampling were used to identify shortnose sturgeon overwintering habitat. From 1996 to 1998 Normandeau Associates Inc[1]. used acoustic telemetry and various types of net sampling to assess the potential impacts of proposed dredging and construction in the City of Bath on both shortnose and Atlantic sturgeon populations in the Kennebec River. From 1998 to 2001, gillnet sampling and PIT tagging were used to estimate the abundance of shortnose sturgeon in the Kennebec complex for a second time. In addition, DMR attempted to use radio telemetry in 1995 and 1996 to document the migratory movements and distribution of Atlantic sturgeon in the Kennebec complex.

[1] Study funded by Bath Iron Works.

Methods

Scientific sampling was conducted at sites throughout the Kennebec complex from the last week in April at the earliest to the first week in November at the latest. Three major gear types were used (sinking gill net, floating gill net, and otter trawl), although a small number of sturgeon were taken by beach seine, eel pot, and a commercial gill net. Gill nets ranged from 30-m to 90-m in length, 1.8-m to 3.7-m in depth, and 11.2-cm to 33-cm stretch mesh size. DMR's otter trawl was 4.88-m long with an estimated 3.05-m mouth opening; Normandeau's trawl had a 14-ft headrope, 18-ft footrope, body of 2-in #15 nylon, and codend of 1 1/2-in with 1/4-in liner.

In all the studies, healthy and dead sturgeon typically were measured and weighed in a sling. Measurements included total length (TL), fork length (FL), and head length (HL), measured to the nearest 1 mm; mouth width (MW) and interorbital width (IOW), measured to the nearest 0.01 mm; and weight, measured to the nearest quarter pound with a spring scale. If a large number of sturgeon were caught or if fish appeared stressed, they were released without being measured.

Carlin tags and PIT tags were used to mark individual fish for mark-recapture studies. Prior to 1998, fish were marked externally through the fleshy base of the dorsal fin with a Carlin tag having a special stainless steel bridle. Beginning in 1998, fish were marked with a PIT tag that was injected into the dorsal musculature.

Telemetry studies utilized both radio and acoustic tags, and method of attachment was determined by the reproductive status of the fish. Pre-spawning adults were tagged externally with an acoustic transmitter (shortnose sturgeon) or a radio transmitter and/or an acoustic transmitter (Atlantic sturgeon). Fish captured in the fall were tagged internally with an acoustic transmitter (both species). Mobile tracking from a boat was conducted at least twice a week to locate fish at 103 standard "listening" sites located along the river from Augusta at RKM 74 (river kilometer) to the mouth of the Back River at RKM 6.4.

Atlantic sturgeon captured with different gear types were analyzed separately. Gill net catches were converted to catch-per-unit-effort (CPUE) for each sampling event. Because variously sized gill nets were used, one unit of effort was defined as a 100-m long gillnet fished for one hour. CPUE was not computed for fish captured with an otter trawl or beach seine. Few of the otter trawl samples included a unit of effort (time or distance). Sampling sites were grouped into ecological zones: tidal freshwater riverine (RKM 74-45), tidal freshwater embayment (Merrymeeting Bay, RKM 45-30), and tidal saltwater (RKM 30-RKM 0).

Results

A total of 492 Atlantic sturgeon were captured in the Kennebec complex between 1977 and 2000. Of this total 461 were taken as bycatch during scientific sampling primarily for shortnose sturgeon, and 31 were taken by a commercial harvester. Fish captured during scientific sampling either were tagged (N=272), were released without being tagged (N=156), were recaptured, previously tagged fish (N=10)[2], or were mortalities (N=21). Two of the commercially harvested fish had been tagged, and the tags were returned to DMR.

[2] Database coding changed in the late 1990s, and recapture records are being reviewed for accuracy .

Most of the Atlantic sturgeon taken as bycatch (N=386) were captured with gill nets at 27 of the 70 locations sampled (Figure 3). Effort data was missing for eight fish, which were excluded from further CPUE analysis. Median CPUE was 0.5, but ranged from 0.04 to 20 (individuals per 100-m net fished for one hour). High CPUE values occurred at tidal freshwater sites in June and July; in the tidal embayment (Merrymeeting Bay) in July through October; and in tidal saltwater in all months except November (Table 1) The highest CPUE (20.0) was at a Bath Iron Works site (T2 in July).

Seventy five Atlantic sturgeon were captured at 11 sites sampled by MDMR or Normandeau Associates Inc. with an otter trawl. All of the fish caught in tidal salt water were taken in the immediate vicinity of Bath Iron Works as part of an environmental assessment (Table 2).

Captured Atlantic sturgeon that were measured ranged in size from 228 to 22.5-cm TL (N=429) with the greatest range of sizes occurring in June, and the largest fish being captured in June and July (Figure 4).

The Kennebec complex clearly supports a spawning population of Atlantic sturgeon. Forty-one of the 55 largest Atlantic sturgeon, 130.8 to 223.5-cm TL, were in spawning condition, primarily males that were expressing milt. Thirteen of these spawning fish were taken by the commercial harvester. Fish in spawning condition have been taken in multiple years (1978, 1980, 1994, 1996, and 1997). Fish in spawning condition and most fish $\geq$130-cm TL were captured in the tidal freshwater zone (RKM 52.8 to RKM 74) in June and July (Table 1).

Tidal saltwater habitat, particularly the area around Bath Iron Works, Pleasant Cove and Winnegance Cove (Figure 3; Site 13, Site 33 and BIW), may be important feeding areas. The majority of the 366 sturgeon less than 130-cm TL (or not measured) were found in tidal saltwater from April through November (Table 2). This same pattern of habitat use is also seen in the CPUE data.

To determine the migratory movements and better delineate spawning habitat, Atlantic sturgeon (157.5 to 198.1-cm TL) captured near suspected spawning areas were fitted with a radio transmitter (N=2 in 1996; N=7 in 1997) or both a radio transmitter and an acoustic transmitter (N=3 in 1997). These fish were never detected again.

To determine the potential environmental impacts of several proposed projects near Bath, Normandeau Associates Inc. fitted each of three Atlantic sturgeon with an acoustic transmitter in 1998. These fish were detected in the area from 23 April to October 20.

Atlantic Sturgeon – 2009-2011 data summary

Summary

In 2009, MDMR initiated a targeted telemetry study of Atlantic sturgeon to identify critical habitats (spawning, overwintering, feeding), and a mark-recapture study to determine the size of the population. In addition tissue samples were taken for genetic analysis. In 2011 a total of 37 Atlantic sturgeon were caught, 11 were acoustically tagged (7 external 3-year tags; 4 internal 10-year tags), and 34 were PIT-tagged and had a tissue sample taken. Three putative Atlantic sturgeon larvae were captured at the spawning site in the Kennebec, and a second spawning area was documented in the Androscoggin. Two of the Androscoggin spawners had been PIT-tagged in the Saco River. Acoustically tagged sturgeon (all years combined) remained on the spawning ground for 0.8-28.2 days where they exhibited two or three peaks of activity, and the majority did not leave the system after spawning. During the three years of this study, 51 Atlantic sturgeon tissue samples were collected for DNA analysis, more than doubling the extant sample size for the Kennebec complex. Eighteen Atlantic sturgeon tagged in the Saco River and 27 tagged in the Penobscot River have been detected in the Kennebec complex during this study, but only four ventured upstream of rkm 45 for more than a few hours. In 2012 we propose to use side-scan sonar to estimate the number of spawning Atlantic sturgeon.

Introduction

Atlantic sturgeon currently inhabit the Kennebec complex, which encompasses seven rivers and two connecting passages (Figure 1). Maine' s second (Kennebec) and third (Androscoggin) largest rivers and four small tributaries combine to form Merrymeeting Bay, below which the Kennebec travels approximately 30 km before entering the Gulf of Maine. The lower Kennebec and the Sheepscot River are connected by the Sasanoa River (oriented NW to SE) and Back River (oriented SW to NE).

The Kennebec complex can be divided into six ecological zones on the basis of salinity and geomorphology. The "lower Kennebec" from its mouth at river kilometer (rkm) 0 to Merrymeeting Bay at rkm 30 is relatively narrow and deep with salinity ranging from 0-32 ppt depending on location and freshwater discharge. The "S-B passages" (Sasanoa and Back rivers) form a mixing zone between the lower Kennebec and the lower Sheepscot. "Merrymeeting Bay" from rkm 30 to rkm 42 is generally <2 m deep at low tide, has extensive intertidal mudflats dominated by *Zizania aqutica* L. (wild rice), and salinity that rarely exceeds 5 ppt . The 13-km long, tidal portion of the "Androscoggin" between Pejepscot Falls, current location of Brunswick Project dam, and Merrymeeting Bay is characterized by large outcroppings of ledge in the upper 0.5 km, while the lower 9 km is braided channel. The "middle Kennebec" is tidal from rkm 42 to rkm 75, has a defined channel for much of its length, and is characterized by a variety of substrate types. The "upper Kennebec" from rkm 75-102 is riverine.

Limited information about the Atlantic sturgeon population in the Kennebec complex has been gleaned from commercial catches and studies conducted between 1977 and 2000 by the Maine Department of Marine Resources on shortnose sturgeon, which captured 457 Atlantic sturgeon as

bycatch. Captured and harvested Atlantic sturgeon that were measured ranged from 225 to 2280-mm TL (N=429). Although 60% of the captured Atlantic sturgeon were marked with an external Carlin tag, too few were recaptured to permit a population estimate. High catch-per-unit-effort (CPUE) values occurred in the middle Kennebec in June and July, in Merrymeeting Bay from July through October, and in the lower Kennebec in all months except November. During June and July, Atlantic sturgeon in spawning condition and fish $\geq$1500-mm TL were captured in the middle Kennebec between rkm 58 and to rkm 74.

In 2009, MDMR initiated a targeted telemetry study of Atlantic sturgeon to identify critical habitats (spawning, overwintering, feeding) and a mark-recapture study to determine the size of the population. In addition tissue samples were taken for genetic analysis. Behavior of Atlantic sturgeon observed in this telemetry study was compared to the behavior of Atlantic sturgeon that entered the Kennebec River after being tagged in the Penobscot River.

Methods

The study area encompassed approximately 97 kilometers of the Kennebec River from Phippsburg boat launch at RKM 16 to the first dam on the mainstem (Lockwood Dam) at RKM 102, the tidal portion of the Androscoggin River from Butler Head to the Brunswick Dam (nominally RKM 30 and 31), and the estuarine complex between the Kennebec River and the Sheepscot River. Since 2008, MDMR has deployed and maintained an array of moored acoustic receivers (Vemco model VR2W) at 16-20 sites in the river channel (Figure 3) for approximately eight months (the ice-free period). In 2008 we also placed a receiver in the Sasanoa River (#18), the Back River (#20), the Sheepscot River (#21) and Townsend Gut (#19).

From 2009 to 2011, pre-spawn Atlantic sturgeon were captured in the Kennebec complex with multifilament gill nets with 30.5-mm stretch mesh. Healthy fish were anesthetized, measured, PIT-tagged, tagged externally with an acoustic transmitter (Vemco V16-4H), and a tissue sample was taken. In 2011, non-spawning or post-spawning Atlantic sturgeon also were captured in the Kennebec complex. Healthy fish were anesthetized, measured, PIT-tagged, and a tissue sample was taken. A subset of the larger individuals were internally tagged with an acoustic transmitter. All sampling was conducted following protocols in Moser (2000) and permit conditions.

In all three years we attempted to capture eggs and larvae of Atlantic and shortnose sturgeon with D-nets to confirm spawning. The net was constructed of 1600-μ mesh, had a 1-m diameter opening, and was 4.3-m long. In 2009, 15 sets were made between May 19 and August 13; in 2010, eight sets were made between May 17 and June 21; and in 2011, 20 sets were made between May 3 and July 26.

Results and Discussion

A total of 56 Atlantic sturgeon and seven shortnose sturgeon were captured in 95 gill net sets (306.8 h fishing time) between 2009 and 2011 (mean Atlantic sturgeon CPUE=0.18 fish/h). Tissue samples were taken from 48 Atlantic sturgeon, 46 were PIT tagged, 20 were tagged externally and 4 were tagged internally with an acoustic transmitter (Table 3). More than half (31) were caught on the spawning ground in the middle Kennebec (rkm 72-75) between June 16

and July 22. They ranged in size from 1520-1990-mm TL. In 2011, eight Atlantic sturgeon were captured on June 21 in the Androscoggin at a site where shortnose sturgeon are known to spawn. They were similar in size to the Kennebec spawners (1572-1872-mm TL), and one fish was a ripe male. Twenty of the 31 Kennebec spawners and three of the eight Androscoggin spawners were tagged with external acoustic transmitters. In 2011, nine large Atlantic sturgeon (1328-1944-mm TL) were caught in Merrymeeting Bay on August 23, and each of four were internally tagged with an acoustic transmitter with a 10-year tag life.

Spawning habitat and behavior

Atlantic sturgeon began spawning in the mainstem Kennebec in mid-June if freshwater discharge was approximately <20,000 cfs. We first captured sturgeon on the spawning ground on June 17 in 2010 and June 16 in 2011 (Table 3). Surface water temperature on these dates was $\geq$ 17º C. In both years discharge in June and July was less than 14,000 cfs. By comparison, discharge in 2009 was nearly continuously >20,000 cfs from June 20 to July 12, and sturgeon were not caught until July 20.

Acoustically tagged Atlantic sturgeon remained on the Kennebec spawning ground for 1.5-21.7 days before moving below rkm 48. In 2010 and 2011, sturgeon were detected on the spawning ground until July 17, but in 2009 they were detected until August 6. Atlantic sturgeon showed two or three peaks of activity (detections per hour) when on the spawning ground. In 2009 they were most active from 0200-0300 and at 1600 and 2000 h, while in 2010 they were most active at 0400 and 1600 h (Figure 5). In both years they were least active from 0600 to 1300.

Spawning in the Kennebec was confirmed by the capture of three larvae (12-13-mm TL; Figure 3) that we genetically identified as Atlantic sturgeon (Figure 6). Two were caught on July 11, one each at site D-992 and D-7, and one was caught the following day at site D-992. The D-nets had been deployed overnight, and water temperature was 24-25º C (Table 4).

In 2011 we documented Atlantic sturgeon spawning in the Androscoggin River. Eight fish, including one ripe male, were caught just downstream of the Rt 201 bridge on June 21. Acoustically tagged fish remained on the spawning ground for 0.8-28.2 d. Two of the fish previously had been caught and PIT-tagged on the Saco River.

Population estimates

In 2011 we used side-scan sonar (EdgeTech 900kHz) to locate and visualize sturgeon on an overwintering area (Figure 7). The technology allowed us to scan the large concentration of fish in several hours, but we were unable to discriminate species. Most of the fish likely were shortnose sturgeon, but juvenile Atlantic sturgeon may have been present. Side-scan sonar could be used to obtain an estimate of the Atlantic sturgeon spawning population, because there should be little mixing of the two species or of juveniles and adults of the same species during spawning.

DNA

During the three years of this study, tissue samples were taken from 51 Atlantic sturgeon. Thirty-seven tissue samples were taken from fish on the spawning grounds, nine were taken from large fish caught in Merrymeeting Bay in August, and two were from juveniles caught in Merrymeeting Bay in late fall. In addition, three larvae that we caught in 2011 and tentatively identified as an Atlantic sturgeon were preserved for species verification and DNA testing. All tissue samples and the larvae were sent to Dr. Isaac Wirgin.

Bycatch has been identified as a major threat to Atlantic sturgeon. Therefore, it is important to describe the genetic structure of the Kennebec complex population in order to determine the impact of various fisheries that take this species as bycatch. To date the genetic structure (mDNA analysis) of Atlantic sturgeon from the Kennebec complex has been described for a sample of just 19 fish (Wirgin et al. 2000). During the three years of this study we have more than doubled the sample size for genetic analysis.

Habitat use by post-spawn and non-spawning sturgeon

The majority of Atlantic sturgeon that were tagged in the Kennebec complex on the spawning ground did not immediately leave the system after spawning, but were detected for up to 101 days. These fish typically moved into Merrymeeting Bay or the lower Kennebec, but three made excursions to the middle Kennebec (rkm 55-65).

Three sturgeon tagged in 2009 (52185, 52187, 52188) on the spawning ground were detected in subsequent years. Tag 52185 was detected for 0.5 d on May 11, 2010 at rkm 16. Tag 52187 was detected on August 4 and 12 at rkm 72. Tag 52188 was detected on May 25 and 28 at rkm 48.

Eighteen Atlantic sturgeon tagged in the Saco River and 27 tagged in the Penobscot River have been detected in the Kennebec since 2007. The majority have rarely ventured upstream of rkm 45 for more than a few hours. In 2009 one fish tagged in the Penobscot was detected at RKM 102 on four occasion between June 26 and August 9, and in 2010 one fish was detected between rkm 55 and 75 for most of June. In 2010 two fish tagged in the Saco were detected in from rkm 48-65 in September and early October. In 2011 three Atlantic sturgeon tagged in the Saco were detected at spawning sites; one in the middle Kennebec and two captured in the Androscoggin.

References

Moser, M.L., M. Bain, MR Collins, N Haley, B Kynard, JC O'Herron II, G Rodgers, and TS Squiers. 2000. A Protocol for user of shortnose and Atlantic sturgeons. US. Dept. Commerce, NOAA Technical Memorandum NMFS-OPR-18. 18 Pages.

Wirgin, I., J.R. Waldeman, J. Rosko, R. Gross. M.R. Collins, S.G. Rogers, and J. Stabile. 2000. Genetic structure of Atlantic sturgeon populations based on mitochondrial DNA control region sequences. Trans. Am. Fish. Soc. 129: 476-486.

Table 1. Catch-per-unit-effort (CPUE) by month and site for Atlantic sturgeon captured in scientific gill net sampling between 1977 and 2000. Stations are arranged from head-of-tide at RKM 74 to the mouth of the Kennebec at RKM 0.

			CPUE						
Zone	RKM	Site	May	Jun	Jul	Aug	Sep	Oct	Nov
1Tidal freshwater riverine	74.0	36A			3.61				
1Tidal freshwater riverine	63.7	35D		3.37					
1Tidal freshwater riverine	62.9	35B			0.83				
1Tidal freshwater riverine	62.6	35A		2.00					
1Tidal freshwater riverine	61.7	12			0.04				
1Tidal freshwater riverine	57.7	11			0.08				
1Tidal freshwater riverine	52.8	9		0.04					
2Tidal freshwater embayment	41.0	42						1.38	0.35
2Tidal freshwater embayment	40.0	14				0.57			
2Tidal freshwater embayment	33.7	4	0.08	0.08	1.24		0.63	0.60	
2Tidal freshwater embayment	30.3	1					0.71	2.50	
2Tidal freshwater embayment	29.7	1A					0.25		
2Tidal freshwater embayment	29.0	8			0.08	0.50	0.17		
3Tidal saltwater	26.0	24				1.00		0.79	0.05
3Tidal saltwater	21.5	46				0.33		1.72	
3Tidal saltwater	20.9	15A				0.50			
3Tidal saltwater	20.9	33			1.00	1.91	0.48	0.10	0.06
3Tidal saltwater	20.9	7		0.04					
3Tidal saltwater	20.0	45A	2.82	0.88					
3Tidal saltwater	20.0	45B					0.92	0.17	
3Tidal saltwater	20.0	45D	0.29						
3Tidal saltwater	20.0	46A			0.32	1.67		1.37	0.66
3Tidal saltwater	20.0	T2			20.00				
3Tidal saltwater	17.3	13						0.06	
3Tidal saltwater	17.3	45T6					0.42		
3Tidal saltwater	17.2	13B			0.85	0.65	2.29	1.12	0.05
3Tidal saltwater	13.0	2	0.04	0.04	0.04	0.13	0.13		

Table 2. Catch by month and site for Atlantic sturgeon taken by scientific sampling with otter trawls between 1977 and 2000. Stations are arranged from head-of-tide at RKM 74 to the mouth of the Kennebec at RKM 0. All tidal saltwater samples were taken near Bath Iron Works

				Atlantic sturgeon caught								
Zone	RKM	Site	Total	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
2Tidal freshwater embayment	29	8	1					1			
2Tidal freshwater embayment	31	51A	5						5		
2Tidal freshwater embayment	40	14A	18						18		
3Tidal saltwater	20	T1	18	3	4	2	1	4	2	1	1
3Tidal saltwater	20	T2	8	1	1	2	3			1	
3Tidal saltwater	20	T3	3			2	1				
3Tidal saltwater	20	T4	12	2	4	1		2		2	1
3Tidal saltwater	20	T5	1					1			
3Tidal saltwater	20	T6	1	1							
3Tidal saltwater	20	T7	2		1			1			
3Tidal saltwater	20	T8	6	2		2		1	1		
Total			75	9	10	9	5	10	26	4	2

Table 3. Date and sampling location in the Kennebec complex, number of Atlantic sturgeon caught, acoustically tagged, PIT tagged, and tissue samples taken for DNA analysis for 2009-2011.

Date	RKM	Atlantic sturgeon	Acoustic tag	PIT tag	DNA sample	Date	RKM	Atlantic sturgeon	Acoustic tag	PIT tag	DNA sample
6/16/09	65.0					6/14/11	75.0				
6/17/09	4.6					6/16/11	75.0	1	1	1	1
7/14/09	62.9					6/17/11	75.0	1	1	1	1
7/14/09	63.7					6/17/11	74.0				
7/15/09	72.0					6/20/11	75.0	2	2	2	2
7/16/09	72.0					6/20/11	74.0				
7/20/09	72.0	1	1			6/21/11	31.0	8	3	6	8
7/20/09	73.0					6/29/11	72.0	4		4	4
7/21/09	72.0	2	2			6/30/11	72.0	1			1
7/22/09	72.0	2	2			7/5/11	72.0	2		2	2
9/2/09	33.7	3		1	3	7/8/11	72.0	2		2	2
9/9/09	33.7					7/11/11	72.0	2		2	2
9/10/09	20.0					8/23/11	36.6	9	4	9	9
9/14/09	29.0					8/24/11	36.6				
9/14/09	33.7					8/26/11	36.6				
						9/6/11	30.3				
6/9/10	70.1					9/6/11	36.6				
6/9/10	72.0					9/20/11	31.0				
6/11/10	72.0					9/23/11	4.6				
6/16/10	70.1					9/23/11	17.3				
6/17/10	70.1	1	1	1	1	10/7/11	17.3				
6/23/10	74.0					10/7/11	20.9				
6/24/10	74.0	1	1	1	1	10/25/11	41.0				
6/25/10	74.0	9	6	9	9	10/26/11	17.3				
6/29/10	74.0					10/31/11	20.9				
6/30/10	74.0					11/1/11	17.3				
7/1/10	72.8					11/1/11	20.9				
7/7/10	73.0					11/4/11	41.5				
7/8/10	73.0					11/9/11	41.5	1		1	1
7/9/10	73.0					11/14/11	41.5	2		2	1
10/13/10	29.7					11/15/11	41.5	2		2	
10/14/10	17.2										
10/29/10	41.0										

Table 4. Location and number of D-net samples taken in the Kennebec complex, 2009-2011. RKM 30 is in the Androscoggin, RKM 64.0-72.7 is in the middle Kennebec, and RKM 75-102 is in the upper Kennebec.

		2009				2010		2011		
Site code	RKM	May	Jun	Jul	Aug	May	Jun	May	Jun	Jul
D-13	102.0					2				2
D-20	102.0					2		2		2
D-32	99.0									2
D-34	89.0				2					
D-3	87.5									2
D-28	81.0									2
D-992	75.0									2
D-6	72.7						4	1	2	
D-7	72.0	1	3	2	2					2
D-36	67.0		1						1	
D-11	65.0	2								
D-9	64.0		1							
D-37	30.0		1							

Figure 1. Map of the Kennebec complex, Maine.

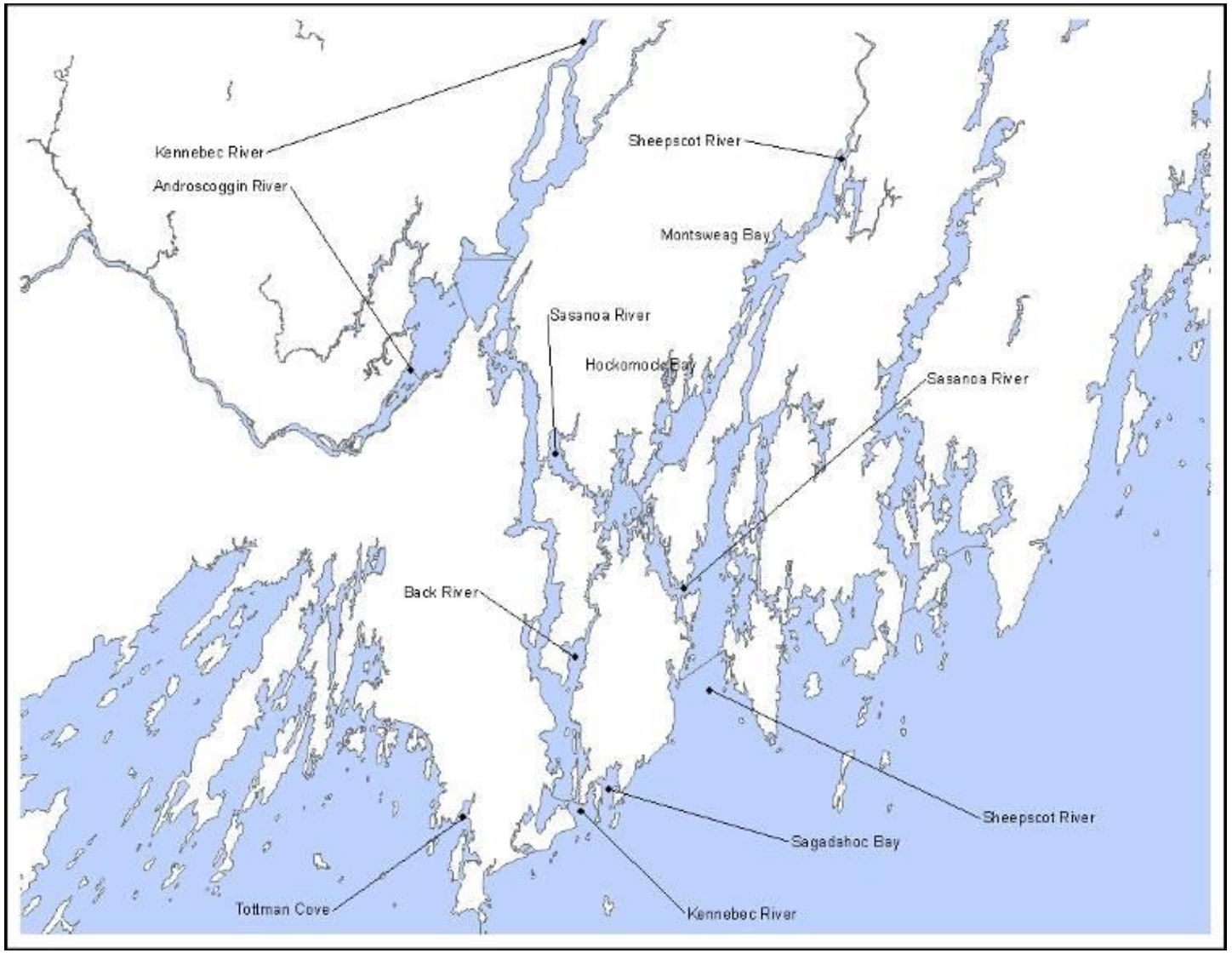
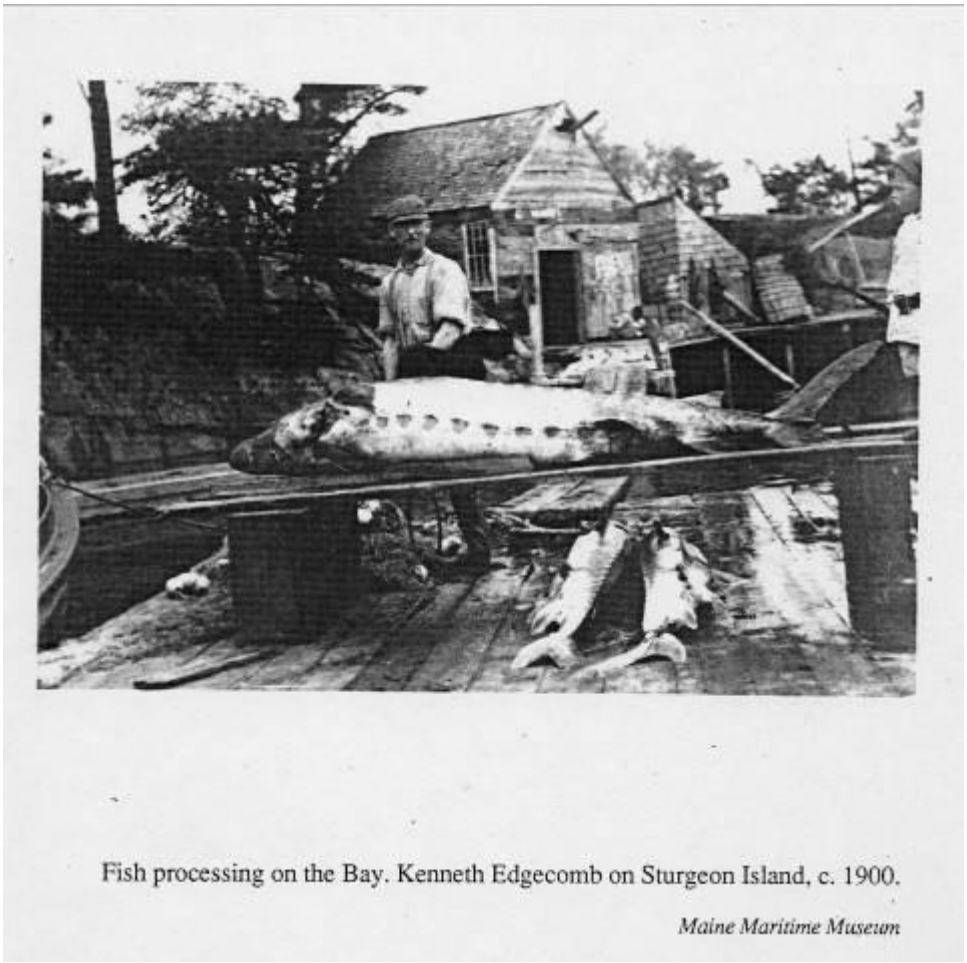


Figure 2. Sturgeon processing in Merrymeeting Bay.



Fish processing on the Bay. Kenneth Edgecomb on Sturgeon Island, c. 1900.

Maine Maritime Museum

Figure 3. Location of gill net sampling site in the Kennebec complex. The large number of sampling locations at Bath Iron Works are not shown individually.

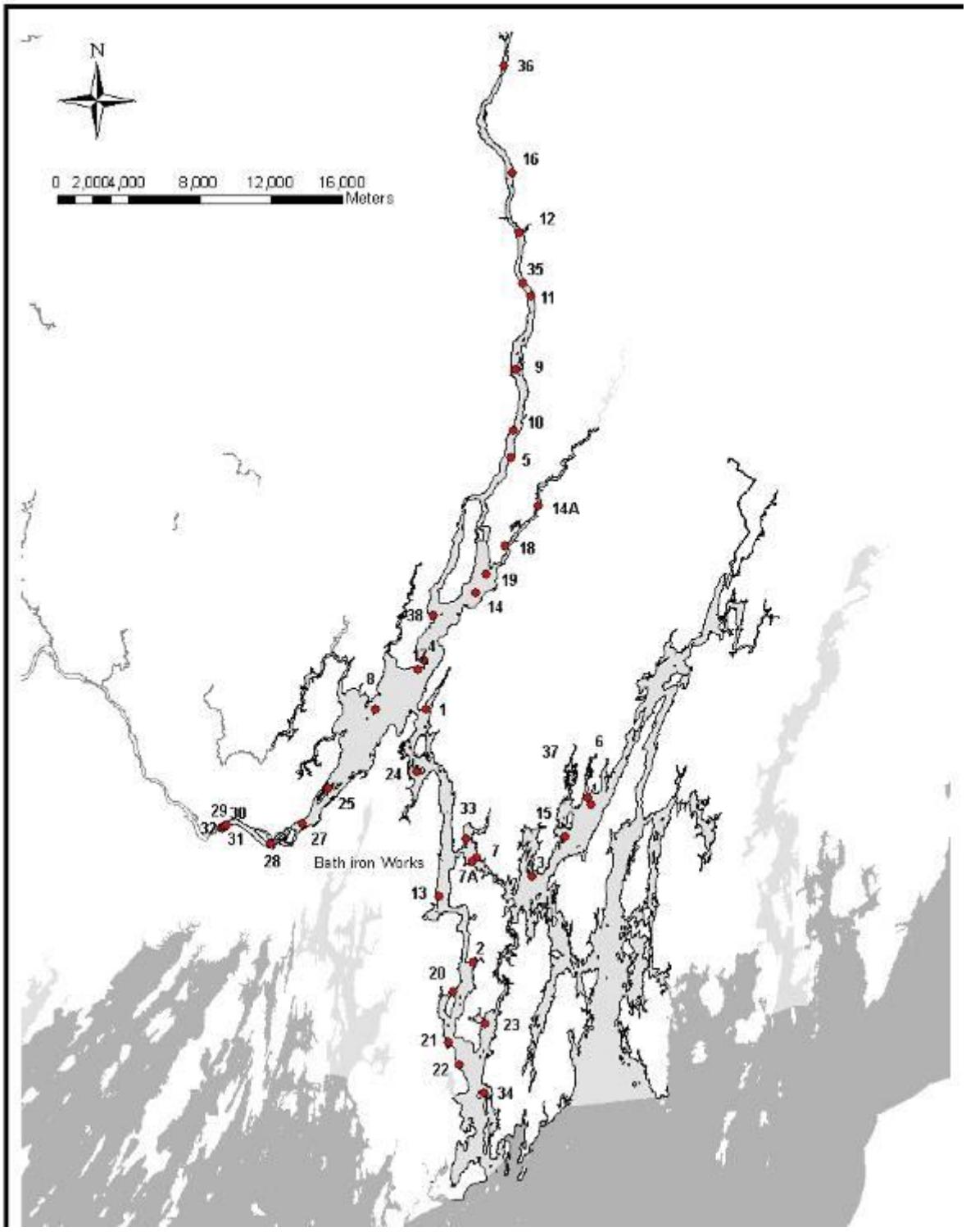


Figure 4. Total length of captured Atlantic sturgeon, 1977-2000.

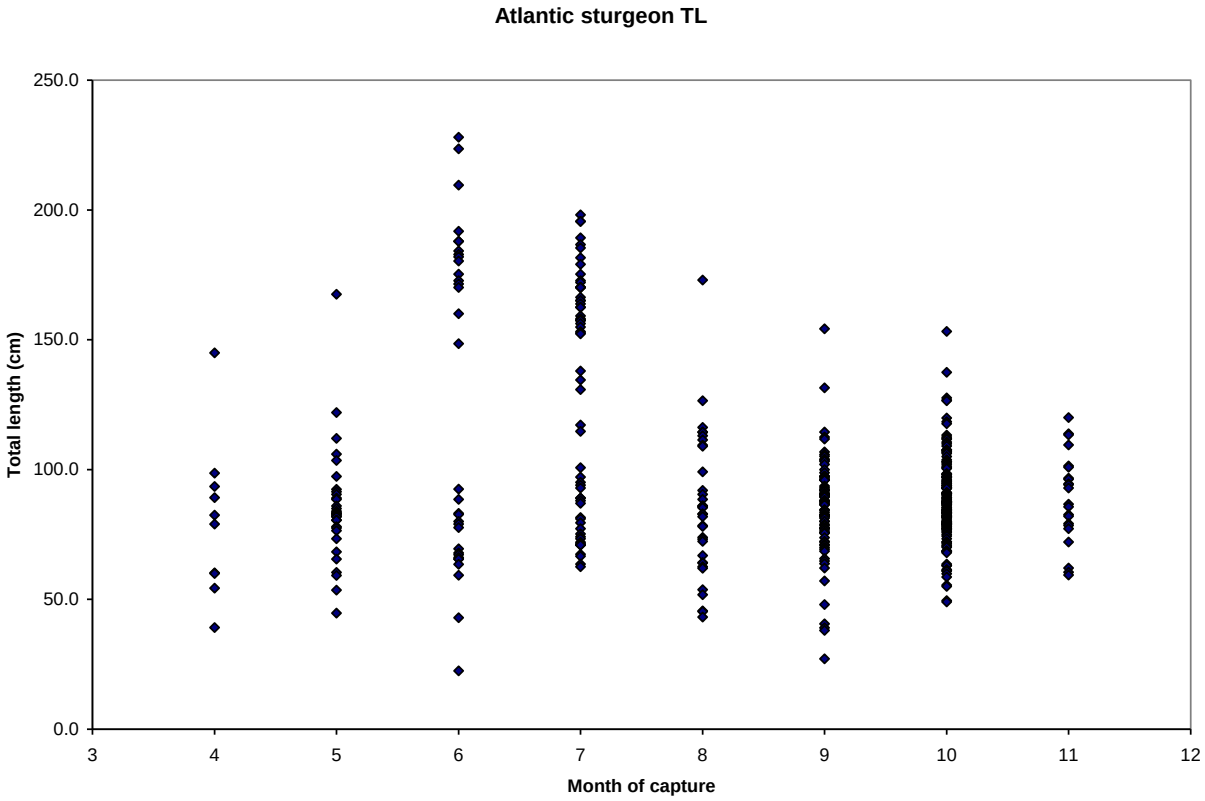


Figure 5. Cumulative plots of time of day of detections for all fish tagged in 2009 (top) and 2010 (bottom).

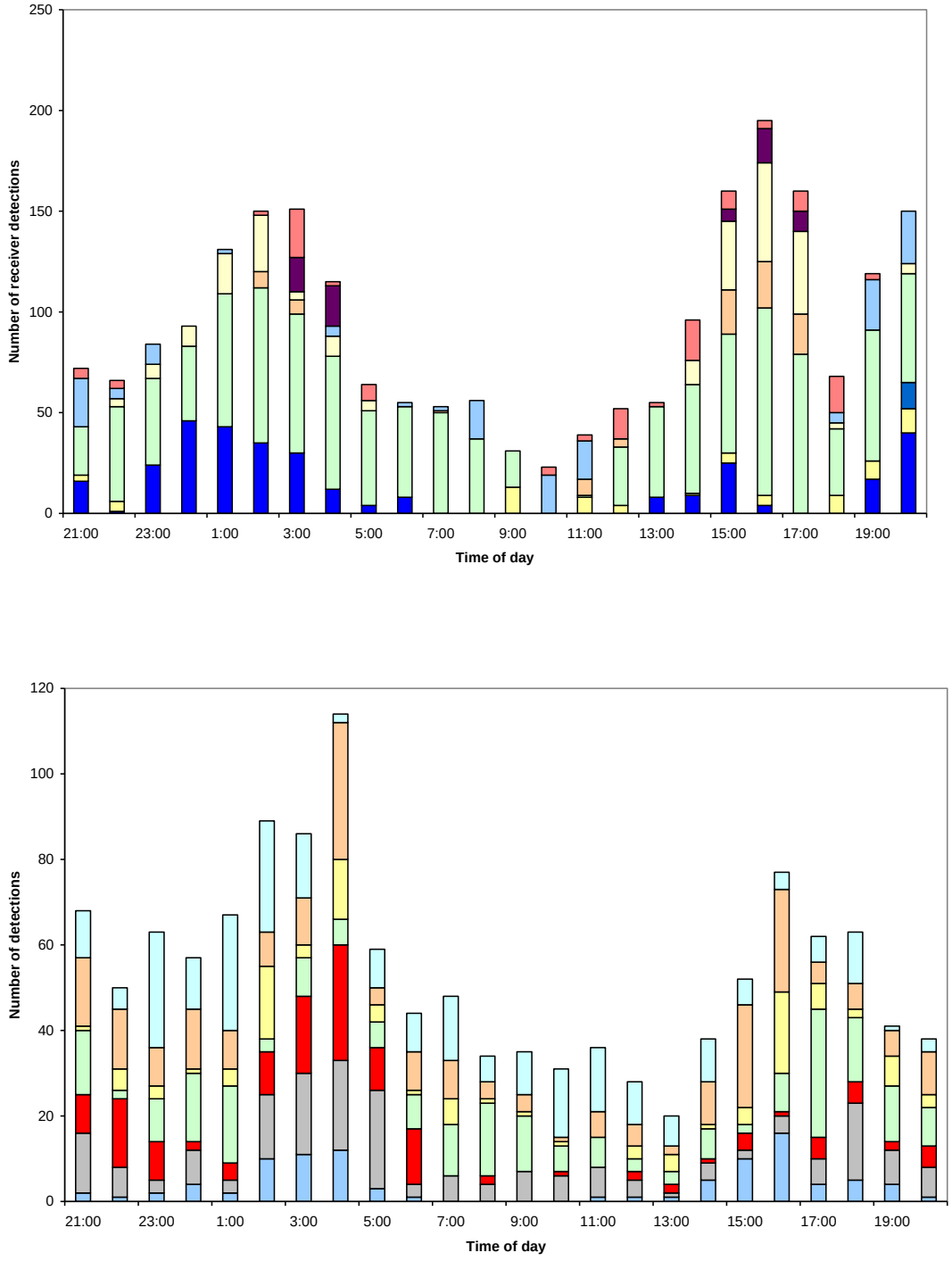


Figure 6. Photograph of putative Atlantic sturgeon larva caught in the Kennebec complex.

Figure 7. Two non-overlapping frames of side-scan sonar imagery of sturgeon from the Kennebec River.