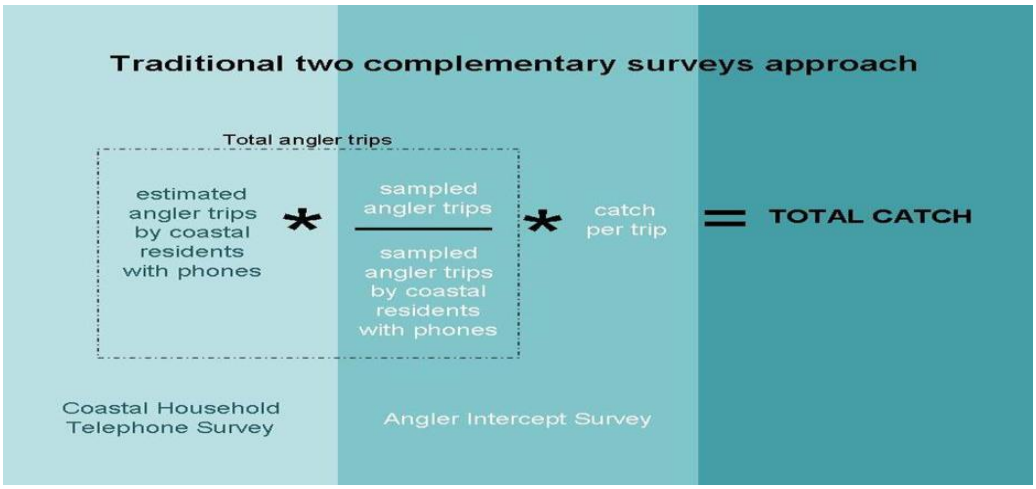
Basic Estimation Methods

The MRIP catch estimates are produced using information from two or more complementary surveys.

- The Coastal Household **Telephone** Survey (CHTS) of private households is used to monitor the numbers of **fishing days** for shore and private boat fishermen. The CHTS collects fishing activity data that can be used to estimate the total number of shore and private mode angler trips (effort).
- The For-Hire Survey (FHS) is a **telephone** survey of for-hire boat operators that is used to monitor the numbers of **day trips** made by fishermen using charter boats and head/party boats. The FHS collects fishing activity data that can be used to estimate the total number of charter/head boat angler trips (effort).
- The Access Point Angler Intercept Survey (APAIS) is a survey **at fishing/marina sites** that monitors the **catch rates** of fishing participants in the shore, private boat, and charter boat modes. The APAIS collects data that are used to estimate catch by species per angler fishing trip. The APAIS interviews are completed on-site and in-person by trained interviewers. In the Northeast, catch for head boats is determined from the observations of sea samplers who monitor catch aboard sampled head boat trips.

Basically, we calculate effort (trips) through the two telephone surveys and average trip catch rates through the on-site APAIS interviews. The effort estimate can be used to expand the mean catch rate to get an estimate of the total number of fish caught. Total Trips multiplied by catch per trip equals total catch. Imagine if 5 people made 15 trips total and averaged one black sea bass and two cod per trip. That would work out to 15 black sea bass and 30 cod. We do this for every species and every type of fishing and add everything up to get totals.

As you can imagine the math is a bit more complicated but this is the fundamental approach. For example, it is usually necessary to make adjustments to the effort estimates produced by either the CHTS or the FHS. The CHTS can't reach people in inland states based on our calling methods, so we use information from the on-site APAIS survey about how many people are coming from inland states to adjust the estimates accordingly. A similar adjustment is made for the FHS charter angler trip estimate to account for angler fishing trips on charter boats not included in that survey (it's voluntary). This basic estimation process for shore and private boat fishing is illustrated in the figure below, but again it boils down to total trips multiplied by catch per trip equals total catch.



The following table shows an example of the various components from the complementary surveys that are used to generate catch estimates for private boat mode in Massachusetts.

Massachusetts Private Boat Mode Example*

Year	2011	2011	2011	2012	2012	2012	2013	2013	2013
Wave	**3**	**4**	**5**	**3**	**4**	**5**	**3**	**4**	**5**
Original Effort	237,114	392,138	301,444	359,247	562,259	133,695	333,813	503,932	365,785
Adjustment	1.3688	1.3162	1.3104	1.3794	1.3646	1.3634	1.4499	1.3306	1.1763
Adjusted Effort	324,558	516,118	395,008	495,548	767,233	182,279	484,010	670,539	430,270
A Catch Per Effort	0.0070	0.0024	0	0.0226	0	0.0122	0.0739	0.0153	0.1212
B1 Catch Per Effort	0.2315	0.0687	0.0511	0.5350	0.0101	0.3058	0.0616	0.0569	0.0443
B2 Catch Per Effort	0.4513	0.1671	0.1164	0.8452	0.2625	0.6488	0.3519	0.8898	0.5697
A Catch Estimate	2,270	1,228	0	11,214	0	2,232	35,769	10,275	52,139
B1 Catch Estimate	75,127	35,477	20,201	265,101	7,774	55,745	29,816	38,185	19,065
B2 Catch Estimate	146,481	86,245	45,988	418,828	201,393	118,257	170,333	596,664	245,145

*Note: Due to rounding error, if you calculate the estimates above, you won't get exactly the same numbers shown.

In the above example, we start with the original estimated private boat mode effort for Massachusetts from the CHTS for two-month sample intervals (Waves) 3 (May-June), 4 (July-August), and 5 (September-October) for the years 2011, 2012, and 2013. We then calculate the coverage adjustment factor (the accounting for people not able to be surveyed as described above) for that wave and multiply it by the original effort to get an adjusted effort estimate. We then calculate the weighted mean catch per angler trip (Catch Per Effort on the table) from the APAIS survey (for private boat mode, in this case). To arrive at the final estimate for a particular catch type, we multiply the adjusted effort estimate of angler trips by the catch per

trip estimate. We produce estimates for three different catch types. Type A catch estimates are based on fish brought back to the dock and observed and identified by trained interviewers. Type B1 catch estimates are based on reported fish that were used for bait, released dead, or filleted (i.e. they are killed but identification is by individual anglers). Type B2 catch estimates are based on reported fish that were released alive (again, identification is by individual anglers).

Weighting Estimation Example

In the description above, we indicate that we obtain a *weighted* estimate of the mean catch per angler trip from the APAIS data. Per standard survey design methodology, survey weights account for the fact that some people and sites are more likely to have interviews. If a given sample unit had a 1/10 chance of being selected, the assigned weight would be 10. In the APAIS, there are multiple stages of sample selection. To clarify how this is done, we now provide an example. The following numbers are for illustrative purposes only, and don't represent actual numbers used in our survey estimates. The basic idea is that the catches at different sites need to be weighted to account for the different amounts of effort at each site, which affects the probability of talking to any given person.

The first sampling unit for the APAIS is a specific location in space and time. Each interviewing assignment is selected for a specific fishing site and time interval. The probability of selection for a given site-time combination depends on how active the fishing site is expected to be during the time interval as predicted from historical information. For example, let's say that we have three types of fishing sites: **L** for low activity, **M** for medium activity, and **H** for high activity. We may expect the **L**-sites to have about 10 angler trips, the **M**-sites to have about 40 angler trips, and the **H**-sites to have about 100 angler trips during an assigned time interval for interviewing. Let's say for a given area we have 40 **L**-sites, 20 **M**-sites, and 8 **H**-sites. Based on the known activity levels, each **L**-site has a 1/200 chance of being selected, each **M**-site has a 1/50 chance of being selected, and each **H**-site has a 1/20 chance of being selected. Now, let's say we take a small sample of 5 site-days and end up selecting 1 **L**-site, 2 **M**-sites, and 2 **H**-sites. The site weights are the inverse of the selection probabilities, so in this example the weight for **L**-sites would be 200, **M**-site weights would be 50, and **H**-site weights would be 20.

When visiting an assigned site in an assigned time interval, each APAIS interviewer tries to interview as many anglers who have completed fishing for the day as he/she can while keeping track of how many total trips were completed at the site. For the lower activity sites it may be easy to interview every angler trip, while at the higher activity sites, people may be leaving at the same time and the interviewer may not be able to interview every fisherman. For each

assignment, we calculate a second stage selection probability and also create a weight for each interview that is based on the inverse of that probability. At the **L**-site, there were 10 trips as expected and all 10 were interviewed, so the probability is 10/10, or 1 and the weight is also 1. At the **M**-sites, there were 40 trips but only 32 were interviewed, so the probability is 32/40 = 4/5, and the weight is 5/4 = 1.25. At the **H**-sites, there were 100 trips but only 40 were interviewed, so the probability of selection is 40/100 = 2/5, and the weight is 5/2 = 2.5. The overall weights assigned to each trip can then be calculated by multiplying the site-time-selection weight by the trip-selection weight. For the **L**-sites, that would be 200*1 = **200**. For the **M**-sites, that would be 50*1.25 = **62.5** and for the **H**-sites, that would be 20*2.5 = **50**. To calculate the weighted catch per unit effort for a particular species, we sum the product of the number of fish caught by the respective trip weight and then divide by the total sum of the weights themselves. This produces a weighted average that correctly reflects the sample design.

The table below shows this weighted estimation example and each of the steps in calculating weighted estimates. Let's say that we're interested in species X. At the **L**-site that was selected, a total of 6 fish of species X were caught among the 10 interviewed trips. At the **M**-sites, a total of 30 fish of species X were caught among the 64 total interviewed trips across **M**-sites. At the **H**-sites, a total of 34 fish of species X were caught among the 80 total interviewed trips across **H**-sites. We can then calculate the weighted catch estimate for species X by multiplying the number of fish caught at each site by the appropriate weight and summing them. In this case, the weighted catch estimates are 6*200 = 1,200 for **L**-sites, 30*62.5 = 1,875 for **M**-sites, and 34*50 = 1,700 for **H**-sites. Adding them up, we get 1,200+1,875+1,700 = 4,775. To calculate the weighted catch per unit effort, we need to divide this by the total sum of the weights. We can calculate that by multiplying the correct weights by the total number of interviewed trips for a particular site. In this example, the sum of the weights would be 10*200+64*62.5+80*50=10,000. Therefore, the weighted mean catch per angler trip would be 4,775/10,000=**0.4775**. The “unweighted” mean catch per angler trip could be calculated by taking the total number of fish caught and dividing by the total number of interviewed trips, or 70/154=**0.4545**. However, this is a biased estimate of the actual catch per unit effort because it doesn't reflect the sampling design. This may not look like a large numerical difference from the weighted estimate, but the difference could be much larger for other examples.

Numerical Weighting Example

Site Type	L	M	H	Total	Notes
Number of Sites	**40**	**20**	**8**	**68**	
Expected Trips per Site	10	40	100		
Total Expected Trips	400	800	800	2000	
Probability of Selection	1/200	1/50	1/20		
Site Weight	**200**	**50**	**20**		(Inverse of probability of selection)
# of Trips at Each Site	10	40	100		
# of Interviewed Trips/Site	10	32	40		(Average trips interviewed per site)
Probability of Selection	10/10	32/40	40/100		(# interviewed trips/total trips)
Interview Weight	**1**	**1.25**	**2.5**		(Inverse of probability of selection)
Overall Trip Weight	**200**	**62.5**	**50**		(Site weight*interview weight)
Total Trips Across Sites	10	80	200	290	
Total Interviewed Trips	10	64	80	154	
Total # of Species X Caught	**6**	**30**	**34**	**70**	
Weighted Catch Species X	1,200	1,875	1,700	4,775	
Sum of Weights	2,000	4,000	4,000	10,000	(Sum of interviewed trips*weights)
Weighted Catch per Effort				**0.4775**	(Weighted Catch/Sum of Weights)
Unweighted Catch	6	30	34	70	
Trips Interviewed	10	64	80	154	
Unweighted Catch per Effort				**0.4545**	(Total Catch/Trips Interviewed)