VERDANT POWER

Before the United States of America
Federal Energy Regulatory Commission

ROOSEVELT ISLAND TIDAL ENERGY PROJECT

FERC No. 12611

Final Kinetic Hydropower
Pilot License Application

Volume 4 of 4
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Verdant Power, LLC
New York, NY

APPENDIX A OF RMEE PLANS –

SUMMARY OF RITE PROJECT HYDROACOUSTIC DATA

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RMEE Appendix A

Summary of RITE Project Hydroacoustic Data

DECEMBER 2010

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RMEE Appendix A

Summary of RITE Project Hydroacoustic Data

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RMEE Appendix A

Summary of RITE Project Hydroacoustic Data

The figures and text presented below, A.1 through A.24, represent an overview of the full body of knowledge on fish abundance, presence, and movement through the Roosevelt Island Tidal Energy (RITE) project demonstration area based on fixed hydroacoustic measurements taken from June 2007 to October 2009. The purpose of this Appendix is to summarize the rational supporting the RMEE plans proposed for the RITE Pilot Project, Installs A, B, and C.

Generally, the data strongly supports seasonal fall monitoring, specifically it supports:

- RMEE1 – Fixed hydroacoustics being deployed in Installs B-2 and C.
- RMEE 2 – Stationary DIDSON deployment to coincide with likely periods of high fish abundance based on observations with respect to the tidal cycle and likely observations of fish at slack; and in the bottom and top of the water column.
- RMEE3 – Netting deployment to coincide with likely periods of high fish abundance and again at slack, and inshore to capture a good sample for species characterization.

As previously documented, Verdant Power used an array (24) of split-beam transducers (SBTs) to continuously monitor the East Channel of the East River as well as the impact of Kinetic Hydropower System (KHPS) turbines deployed in the RITE demonstration area. This text consists of figures; analysis and key conclusions that provide the rationale for developing the ongoing monitoring plan presented in the Final License Application.

Summary of Figures and Rationale for RMEE Plans, Timing, and Scope

- Schematic of Fixed Hydroacoustic array and coverage (Figures A.1 – A.2)
  The location of the 24-transducer array and the zonal coverage of the six KHPS machines of the RITE Demonstration project are shown. Install A will use the same six monopile locations; however, only two KHPS Gen 5 machines (not 6) will be installed for the first 180 day run. Similarly, Install B-1 will install three KHPS machines in the same footprint as the demonstration. Conducting additional SBT analysis in this same area is not proposed; or warranted. ***SBTs will be best deployed for future installs*** of more machines (Install B-2 and C) in a larger Pilot Project Boundary as the best approach for Pilot array monitoring at the meso- macro level.

- Temporal Fish Target Abundance – Seasonal Distributions (A.3 – A.5)
  These plots shows total fish targets (events) per day for 2 fish frames from June 2007 to October 2009: over 2 years and 3 fall seasons. ***This figure clearly shows three distinct late fall fish runs and low target presence the remainder of time.*** The lack of maintenance ability causing sequential failure of SBTS and lack of aiming was a significant lesson learned in the application of SBTs for long term monitoring. This limitation is addressed in the RMEE plans proposed.

- Temporal Fish Target Abundance Sized Targets (A.6 – A.8)
  These plots show the comparison of small (<30') and large (>30') fish by month; and supports the rationale that fish observation should be done in the fall season. The lack of abundance of small or large fish in the spring and the passage of small fish followed by larger fish in the late fall run, is consistently supported by the data. ***The opportunity to observe the interaction of operating KHPS on fish is more likely to occur at seasonal high abundance in the fall.***

- Temporal Fish Target Abundance: Water Column Location (A.9 – A.10)
  This series of plots shows the presence of fish within the top-middle and bottom portion of the water column. Comparison with those figures confirms that the ***fewest fish are observed in the middle of the water column during all 10 months*** for most of the frames. This confirms zonal observations that fish targets are not in the zones of impact where turbine blades are rotating. The seasonal variation in fish abundance is clear, and supports other data.

- Temporal Fish Target Abundance: Fish movement on slack (A-11, A-12)
  These plots depict fish movement in both direction (N/S) and swim speed in relation to the tidal speed. ***Not surprisingly fish have a strong movement on the transition from ebb to slack to flood, and vice versa***. This observation provides rationale for conducting netting at times of slack as the opportunity to improve species capture rates as well as the working hypothesis that fish are more active when KHPS are not rotating.

- Temporal Fish Target Abundance: Day/Night (A.13)
  This figure presents the monthly sum of fish from four frames for 3 relevant months for flood/ebb/slack and night/day. The multifold increase in total fish abundance in October is clear, as is the dominant abundance of fish observed during slack tide. ***There is no clear trend in fish observation between night and day.*** This supports conducting fish netting studies during daylight hours consistent with safety concerns.

- Spatial Abundance – Zonal Distributions (A.14)
  This series of three contour plots presents a geographic distribution of fish events observed during ebb, slack and flood tides within the RITE demonstration area. ***There is a clear increase in fish abundance and presence inshore, with an associated absence in the turbine zones and outshore; and abundance during slack***. This again supports the location and timing of proposed RMEE Netting plans.

- Zonal Analysis – Water Column Location(A.15)
  This figure presents a similar spatial representation of fish abundance as Figures A.14-I through A.14-III, however, only a single fish frame during a 24-hour period in July is shown, sorted by location in the water column. As previously, the vast majority of fish are located inshore, away from the turbine zones. Further, most fish are seen in the top of the water column, in agreement with Figures A.9–A-11.

- Zonal Analysis – During Turbine Operation (A.16–A.21)
  Figure A.16 details the low abundance of fish targets in the summer and with respect to operating KHPS units in June 2007. A single KHPS unit was failing near a SBT and "false" fish target data results from the "noise." This demonstrates the acknowledged limitation of the fixed hydroacoustic system too close to rotating machinery.

- Figures A.17-I through A.17-III present details of the fish distribution observed during KHPS turbine operation in the two impact zones. A trend in target strength detection/observations is seen: more small fish near the inshore (T2-T4-T6) turbines, more large fish near the outshore (T1-T3-T5) turbines, ***very few fish (<30 per day) observed in the turbine impact zones.***

- Figure A.18 is a plot of Deployment 3; a period when two KHPS were operating continuously in October 2008. It confirms previous results from Deployment 2 above, ***that very few fish are observed in the turbine impact zones during turbine operation***. Additionally, this plot highlights the value of the body of fixed hydroacoustic data to identify windows of increased fish abundance for scheduling DIDSON monitoring and netting following the working hypothesis below in A.23–24.

- Figures A.19 and 20 are pie chart depictions of KHPS operating periods and segregation by non- impact zones and impact zones; as well as fish target size. Since the KHPS operates when water velocity is > 0.8 m/s, roughly 18 hours per day, and is non-operational the remaining 6 hours per day, this representation is more useful ***in understanding fish movement; which is strongly weighted towards zones where KHPS are not located; or likely to be located in a full field buildout.***

- A.21: Even thought the KHPS turbines at RITE operate for 18 hours per day; the majority of the fish are clearly in the non-impact zones with or without turbine operation. These plots confirm previous observations ***that fish tend to the inshore and non-impact zones of the KPHS turbine array, likely minimizing opportunity for harm.***

- Migratory/Movement Trends (A.22 – A.24)
    - Water Temperature (A.22)
    - Lunar Events (A.23 – A.24)

      This series of plots plot shows the peak migratory period from 2007 with the pertinent lunar events included. The first increase in fish abundance occurs as the water temperature approaches 20°C while the second increase occurs as the water drops below 10°C. While this could be a trigger, the more compelling case for timing relates to tide. Minimum abundance periods within the migration occur on perigean spring tides and new moon/apogee events, when tidal strength is at its

peak. Full moon, new moon coupled with perigean spring tide, maximize tidal strength and do not coincide with higher fish target days, suggesting, rather intuitively that fish prefer to move during minimum tidal currents. ***Therefore, the best time to conduct fish studies is consistent with selecting low tidal current periods, which are totally predictable, at half moon and apogee.*** This working hypothesis as to the peak movement periods at RITE will be utilized to time the deployment of the Seasonal DIDSON and the netting programs of the RMEE.

For the Install A, since tidal cycle is very predictable, this would fall between the following periods; shown on the figure below; in green.

For RMEE 2 – Stationary DIDSON; a 3-week deploy window that commences 3 days before a known low and ends 3 days after the next low would provide two opportunities to observe likely high abundance, movement and migration of fish targets., while remaining within the limitation of the in-water time for the instrument.

For RMEE 3 – Netting; the timing of the netting activities – assuming six; would occur at these low tidal cycles; with an additional two added in September. This not only allows for capturing the highest number of fish, but also is a good compromise on netting efficiency and safety since the lower tidal currents facilitate vessel movement and experimental procedures.

Figure 1 RITE Project Fish Abundance – December 2006 to May 2007 (Four Frames)

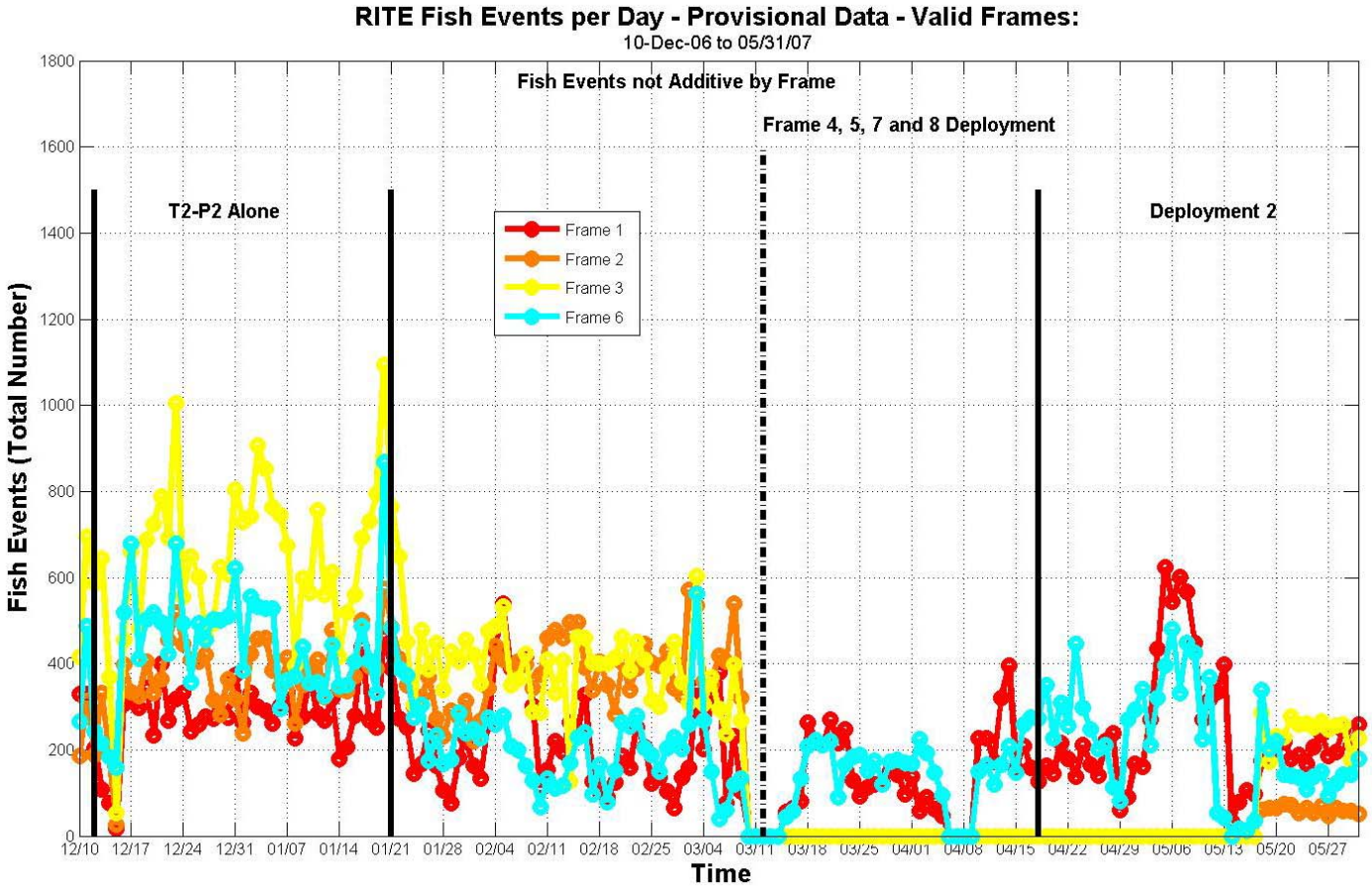

Figure 2-I RITE Project Total, Inshore and Impact Zone Fish Targets during Deployment 3 – September 11 – October 13, 2007: Inshore Zone, Zone 1 (T2-T4-T6) and Zone 2 (T1-T3-T5) (Frame 6)

This plot confirms previous results from Deployment 2, very few fish are observed in the turbine impact zones during turbine operation. Nearly half of the total fish (red) were observed in the inshore zone (green). Further, less than one quarter of the total fish (red) are seen in the two impact zones combined (blue and black). A detailed analysis of the distribution of fish within the water column during turbine operation, Deployment 3, is presented below.

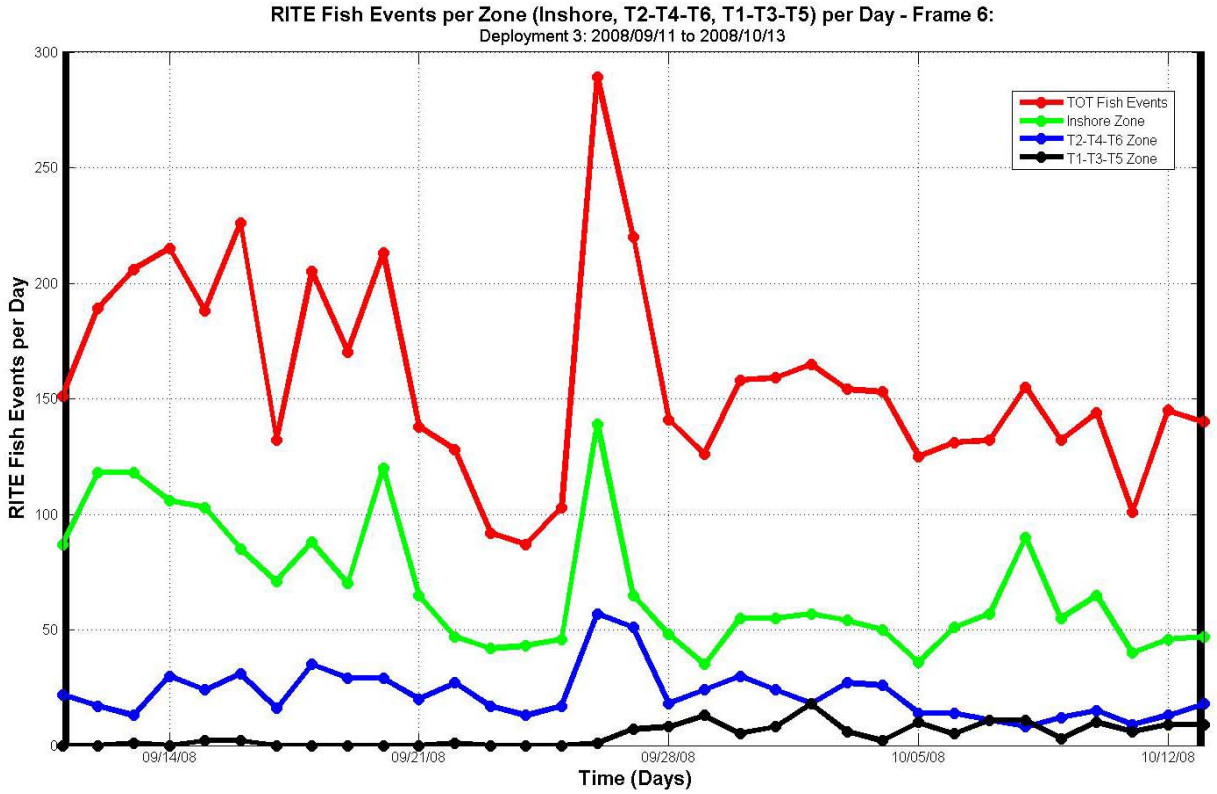

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Figure 2-II RITE Project Total and Inshore Zone Fish Targets per Transducer (X) during Deployment 3 – September 11th – October 13th 2007: Bottom (X3), Middle (X2) and Top (X1) of the Water Colum (Frame 6)

The total fish observed by each transducer, X1 – top water column (dot-dashed line), X2 – middle water column (dashed line), X3 – bottom water column (dotted line) is plotted for the inshore zone with the total fish observed in the inshore zone (solid green line) and the total fish observed (red). It is clear that more than half of the fish observed in the inshore zone are observed in the top of the water column, X1 (shown as the green dot-dashed line). ***As such, roughly one quarter to one third of all fish observations during Deployment 3 occurred in the top of the water column in the inshore zone, far away from any operating turbine, see Figures A.1 and A.2.***

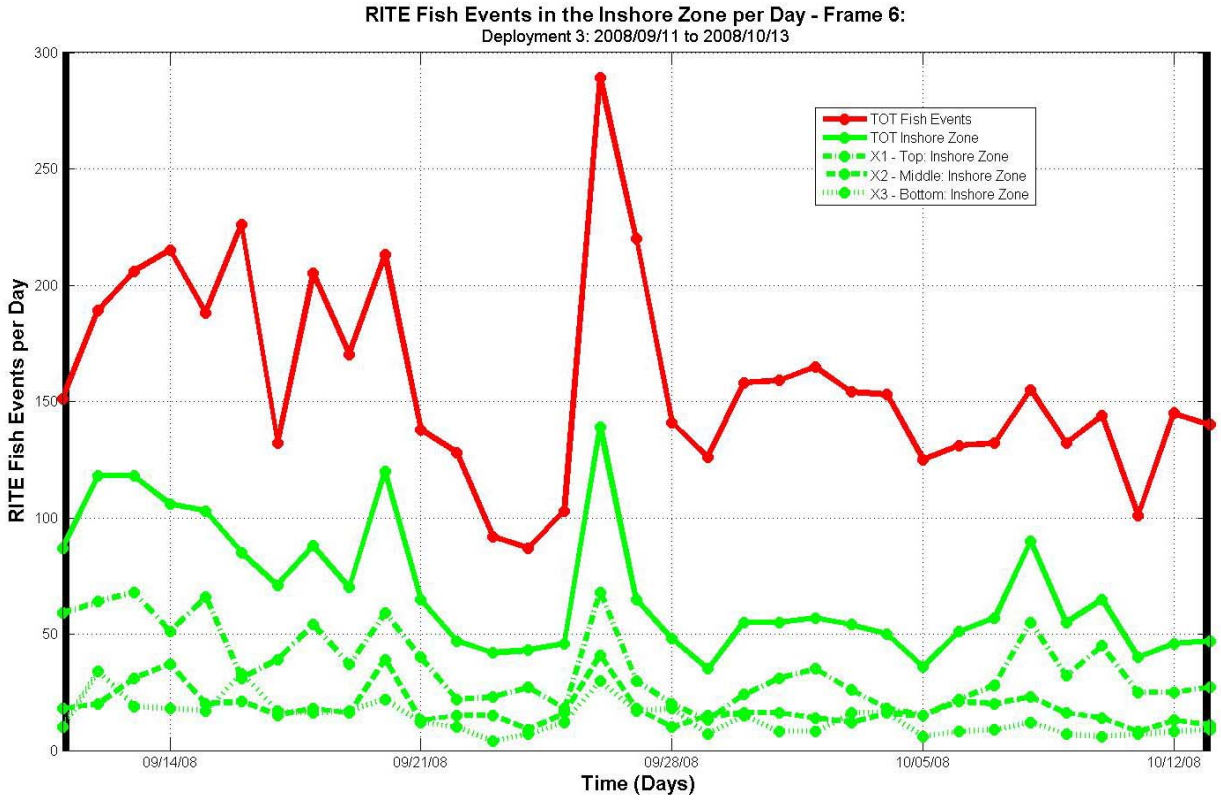

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Figure 2-III **RITE Project Total and Turbine Zone 1 (T2-T4-T6) Fish Targets per Transducer (X) during Deployment 3 – September 11th – October 13th 2007: Bottom (X3), Middle (X2) and Top (X1) of the Water Colum (Frame 6)**

The total fish observed by each transducer, X1 – top water column (dot-dashed line), X2 – middle water column (dashed line), X3 – bottom water column (dotted line) is plotted for the T2-T4-T6 zone with the total fish observed in the T2-T4-T6 zone (solid blue line) and the total fish observed (red). It is clear that a small portion of the total observed fish are seen in the turbine impact zone. Nearly all of the fish observed in the T2-T4-T6 zone are observed in the bottom of the water column, X3 (shown as the blue dotted line). ***As such, a small number of fish were observed during Deployment 3 in the T2-T4-T6 Zone and occurred in the bottom of the water column, likely underneath the rotating blades with operating turbine, see Figures A.2.***

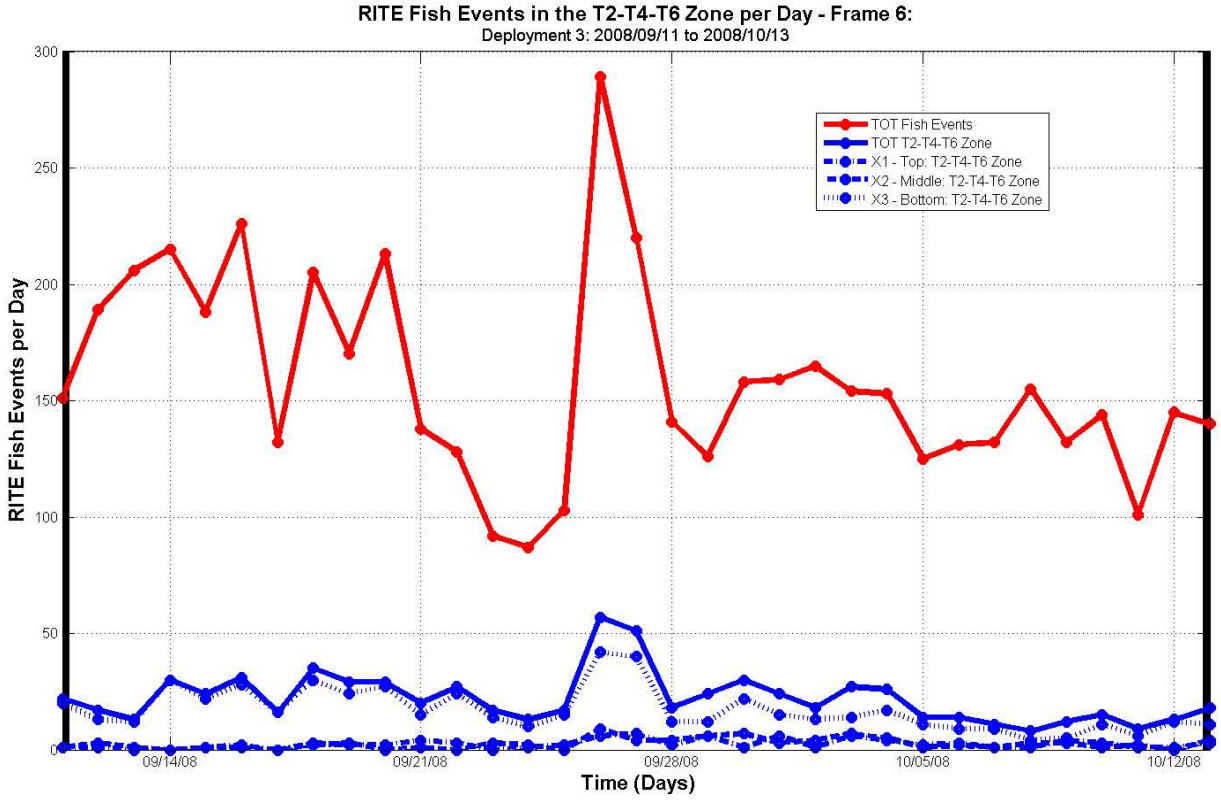

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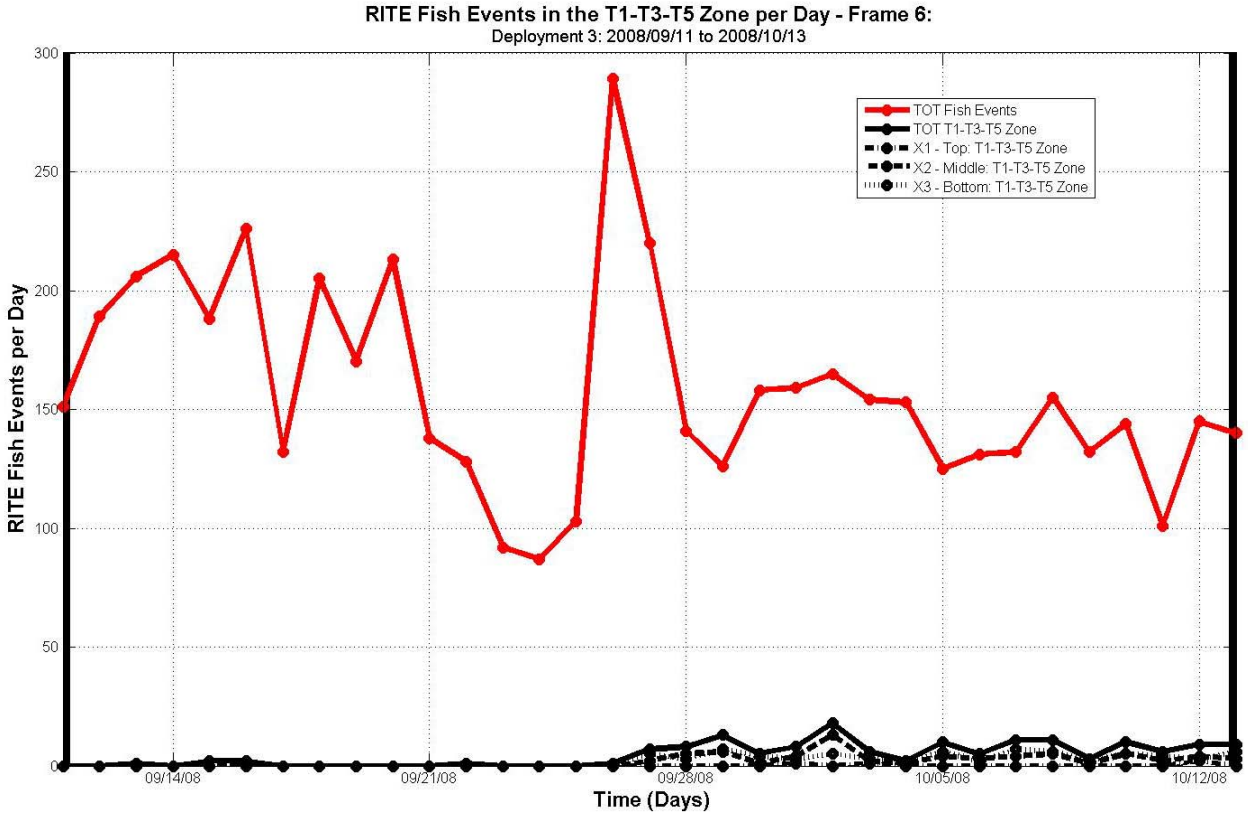
Figure 2-IV RITE Project Total and Turbine Zone 2 (T1-T3-T5) Fish Targets per Transducer (X) during Deployment 3 – September 11th – October 13th 2007: Bottom (X3), Middle (X2) and Top (X1) of the Water Colum (Frame 6)

The total fish observed by each transducer, X1 – top water column (dot-dashed line), X2 – middle water column (dashed line), X3 – bottom water column (dotted line) is plotted for the T1-T3-T5 zone with the total fish observed in the T1-T3-T5 zone (solid blue line) and the total fish observed (red). It is clear that almost none of the total observed fish are seen in the turbine impact zone. The fish observed in the T1-T3-T5 zone are observed in a roughly uniform distribution between the middle and bottom of the water column, X2 and X3 (shown as the blue dashed and blue dotted lines respectively). No fish are observed in the top of the water column. ***As such, a very small number of fish, less than 5%, were observed during Deployment 3 in the T1-T3-T5 Zone and occurred towards the bottom of the water column, see Figures A.2.***



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Summary of RITE Project Turbine Deployments and Split-Beam Transducer (SBT) Data

Deploy	Dates Operating	Days Operating	Number of KHPS	SBT Data
Deploy 1	12/13/06 – 1/22/ 07	41	2	-
Deploy 2	4/13/07 – 6/30/07	78	Up to 6	8 Frames
Deploy 3	9/8/08 – 10/31/08	53	2	5 Frames

See Figure A.1 and A.2 below for Turbine and Fish Frame Location

Figure 3-I RITE Project Fish Abundance, Predicted Tide Height Difference and Lunar Events September 2007 to December 2007 (4 Frames)

This plot shows the peak migratory period from 2007, a subset of the data seen in Figure A.22, with the pertinent lunar events, apogee and half moon, included. The predicted tide height difference is also plotted. It is clear that maximum fish events occur during periods of minimum tide height difference, corresponding to half moons and apogee events. Tide strength is minimized at the half moon and at the apogee, suggesting fish prefer to move during minimum tidal currents. When the apogee and half moon event occur in close proximity to each other, fish abundance is further maximized, seen in mid-October and early December. From this, targeted fish monitoring should focus on days with a half moon, with a preference for half moon days in close proximity to an apogee event. Predictions for 2011 are presented in Figure 4 below. See also Appendix A.

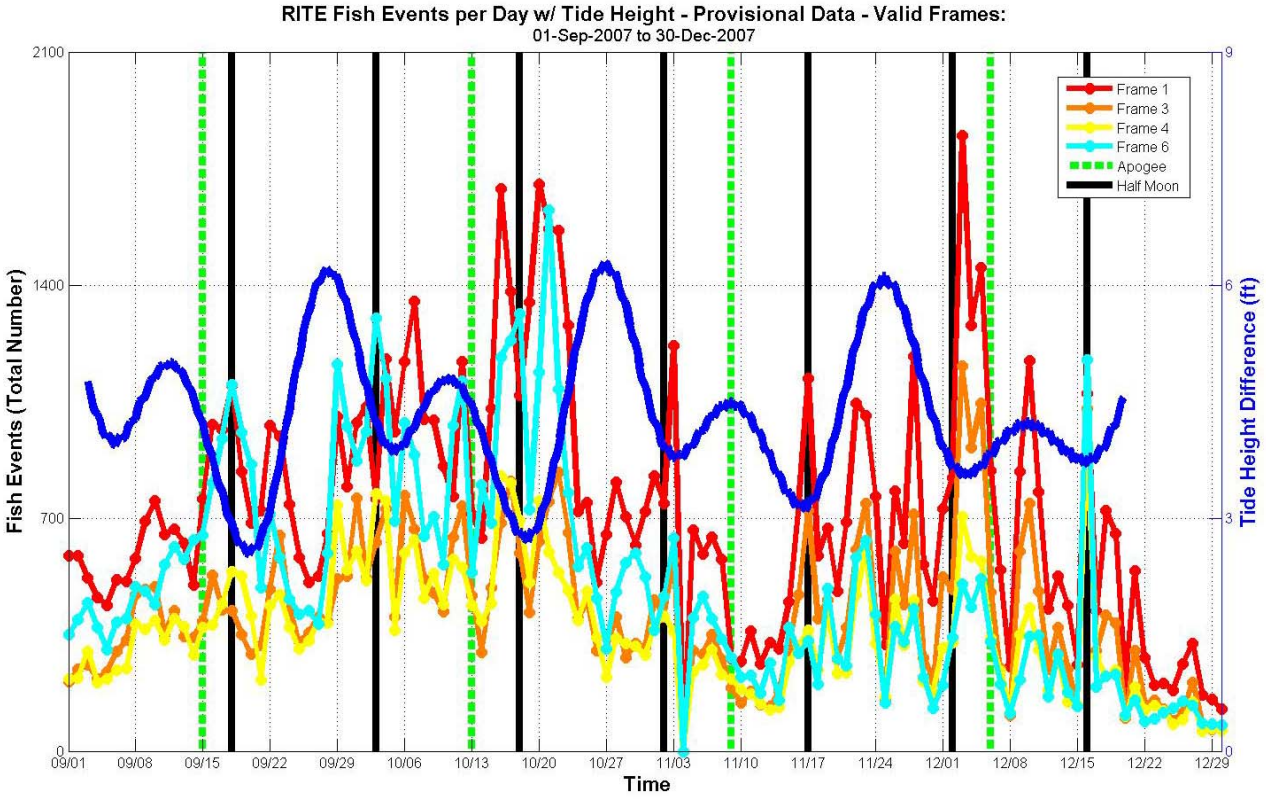

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Figure 3-II RITE Project Fish Abundance, Predicted Tide Height Difference and Lunar Events September 2008 to December 2008 (4 Frames)

This plot shows the peak migratory period from 2008, with similar data to Figure A.23 1 year later. Although fish abundance is reduced compared with 2007, similar trends are observed. An increase in fish abundance is seen on half moon days near apogee and minimum periods of abundance within the migration occur around maxima in tidal height difference, i.e. tidal current strength. The failure of Frame 4 is clear.

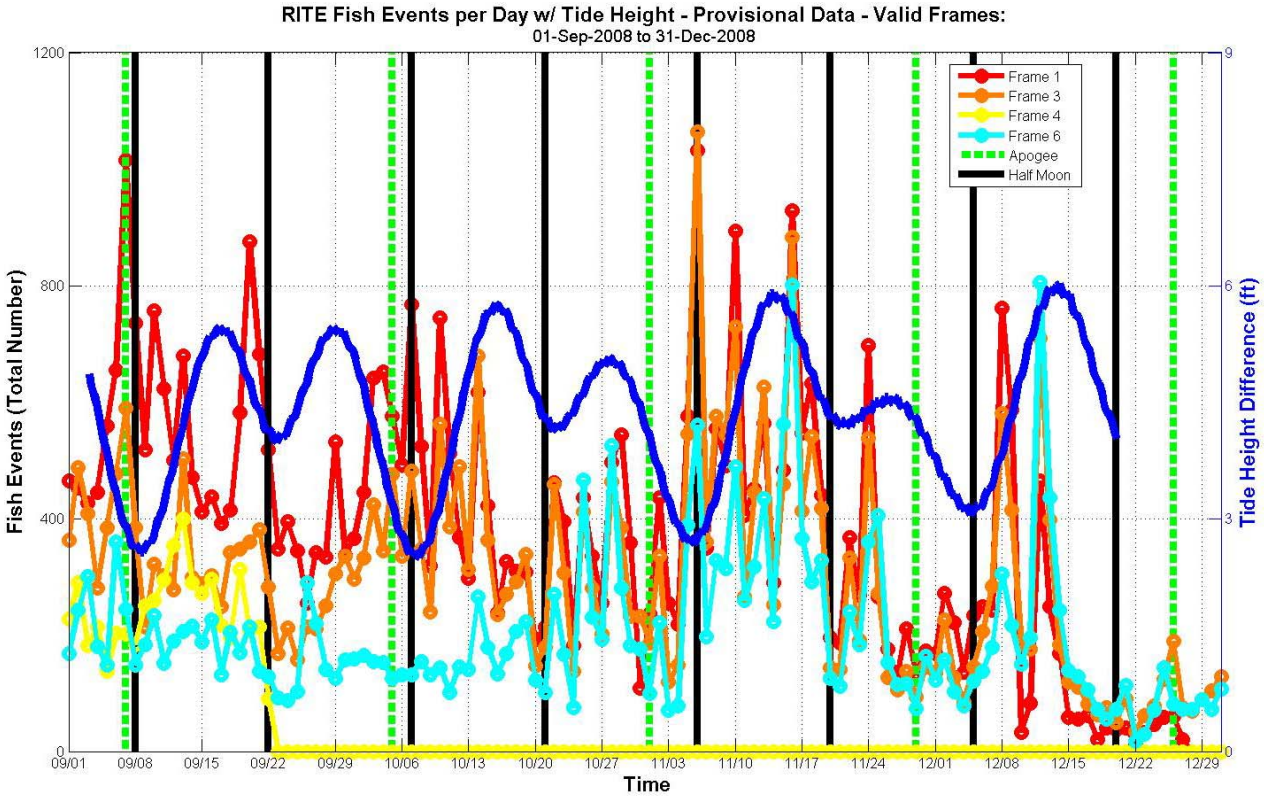

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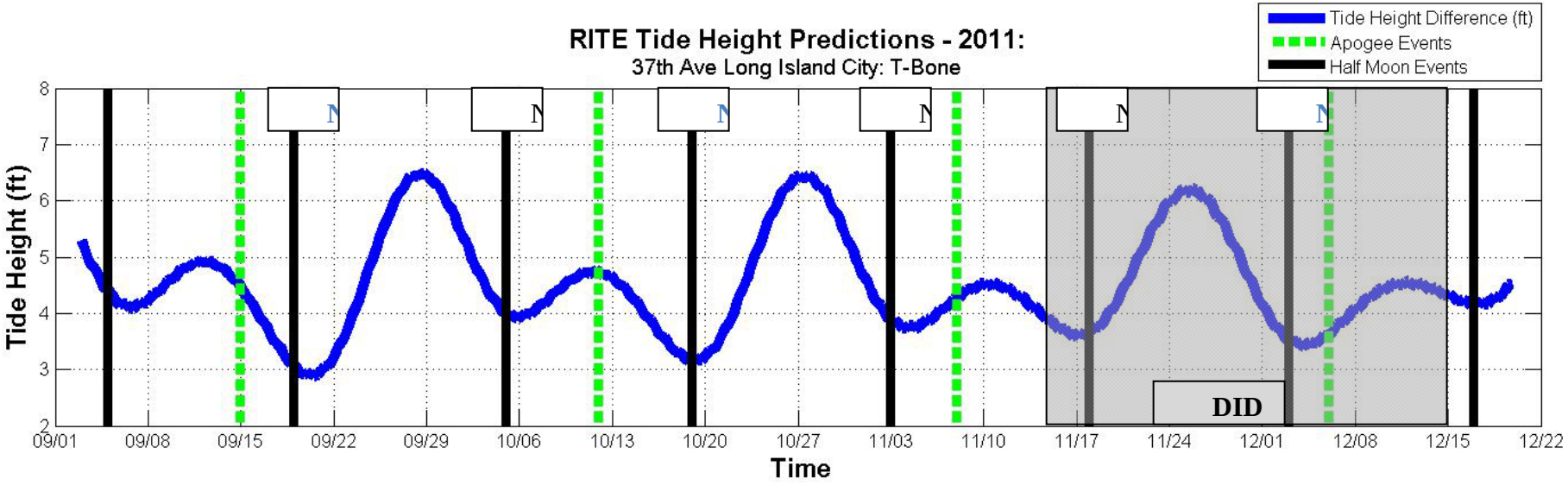
Figure 4 **RITE Project Predicted Tide Height Differences and Lunar Events with Targeted Monitoring Dates September to December 2011**

Based on the evidence presented in Figure A.23 and A.24, targeted seasonal fish monitoring should occur during periods of minimum tide strength. These periods occur during the half moon and are further minimized with an apogee occurrence in close proximity. The tide height difference during the peak migratory period, September through December, is presented for 2011, with half moon and apogee events. 6 suggested netting events (N1 – N6) coincide with the half moon. Preference is given to the half moons closest to an apogee, N1, N3 and N6. The known presence of large fish in December and the half moon/apogee event around December 3rd, 2011 make this an ideal period for stationary DIDSON measurements.



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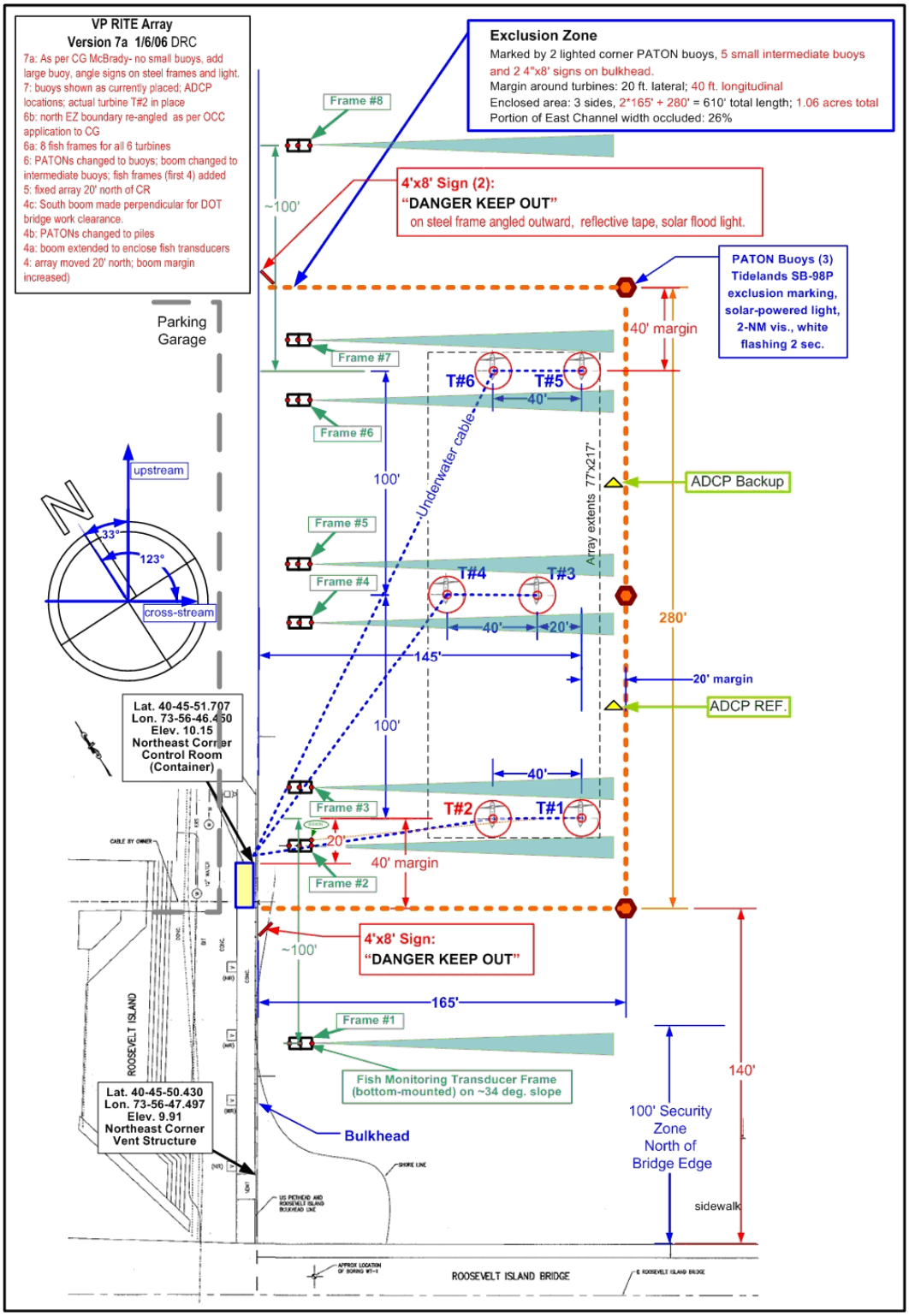
Summary of RITE Project Fish Frame Operation

Frame	Dates Operating	Days Operating	Location
1	6/1/07 – 12/27/08	575	Far-Field South
2	6/1/07 – 5/27/09	726	T1-T2 South
3	6/1/07 – 10/13/09	865	T1-T2 North
4	6/1/07 – 9/22/08	479	T3-T4 South
5	6/1/07 – 9/29/08	486	T3-T4 North
6	6/1/07 – 11/8/09	891	T5-T6 South
7	6/1/07 – 8/14/08	440	T5-T6 North
8	6/1/07 – 7/24/09	784	Far-Field North

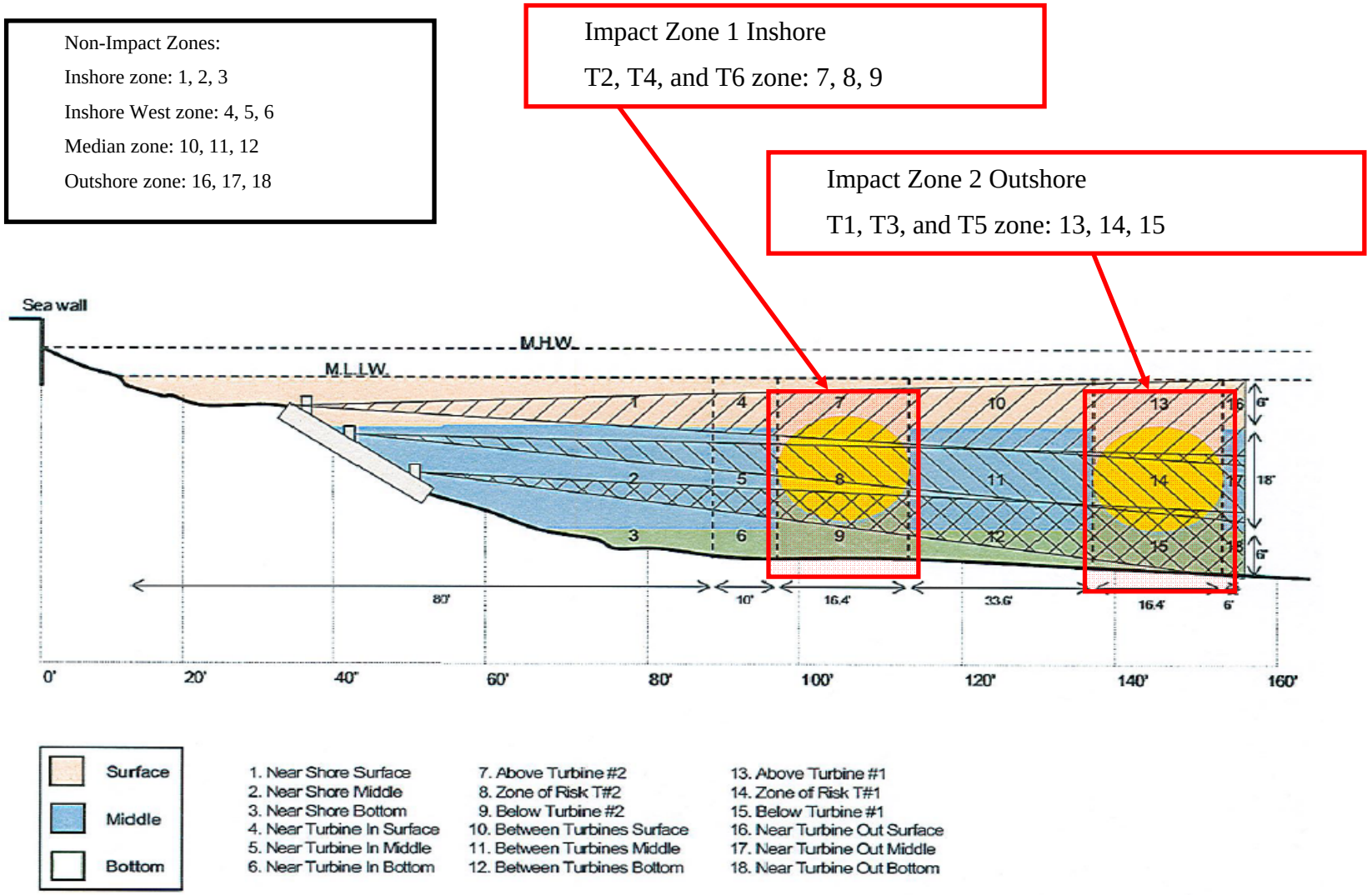
**** See Figure A.1 and A.2 below for Turbine and Fish Frame Location***

Figure A.1 RITE Project Fish Frame and Turbine Location Definitions



**** Presented in "Attachment A RITE FMPP Fixed Hydroacoustics DATA"***

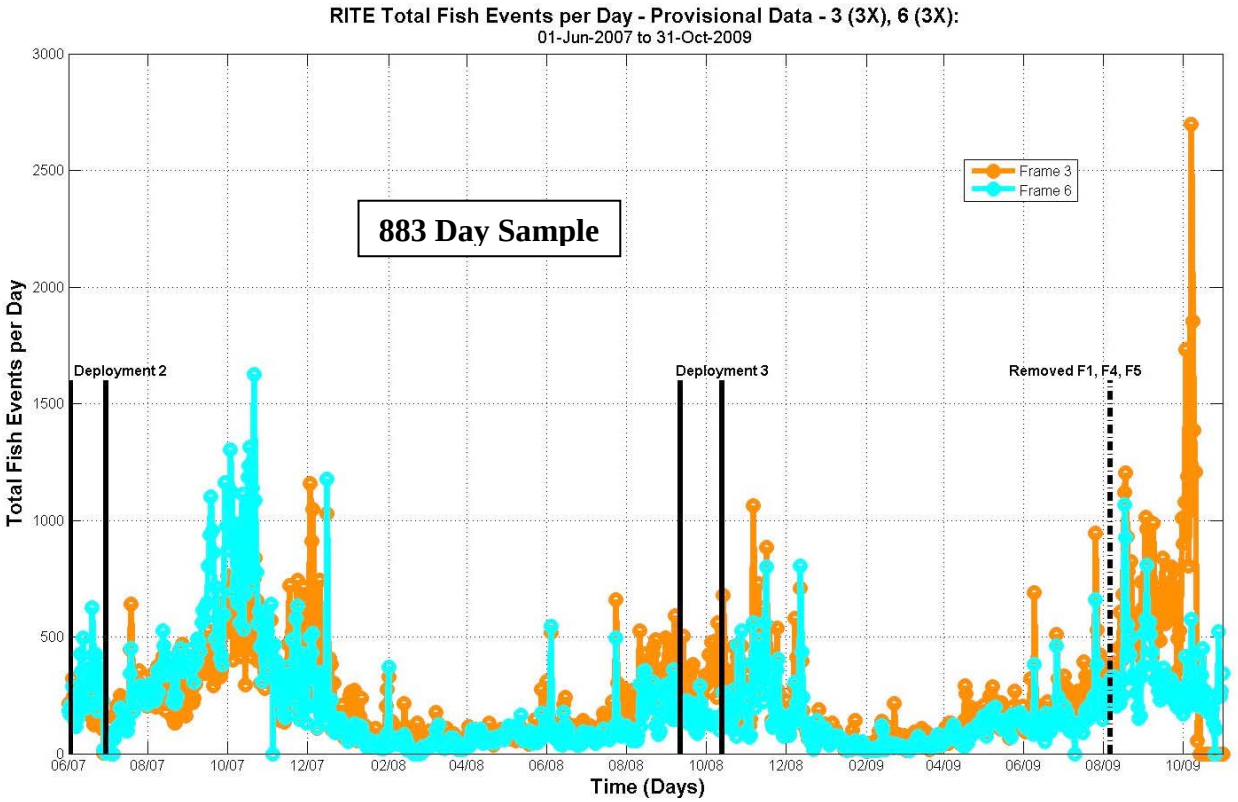
Figure A.2 RITE Project Fixed Hydroacoustic Zonal Coverage Definitions



**** Presented in "FERC Draft License Application – Volume 2 – Exhibit E"***

This plot shows total fish targets (events) per day for 2 fish frames from initial deployment to final failure, over 2 years. ***This figure clearly shows three distinct late fall fish runs and low target presence the remainder of time.*** Pertinent in-water events are highlighted as well. The lack of maintenance ability causing sequential failure of SBTS and lack of aiming was a significant lesson learned in the application of SBTs for long term monitoring. This limitation is addressed in the RMEE plans proposed.

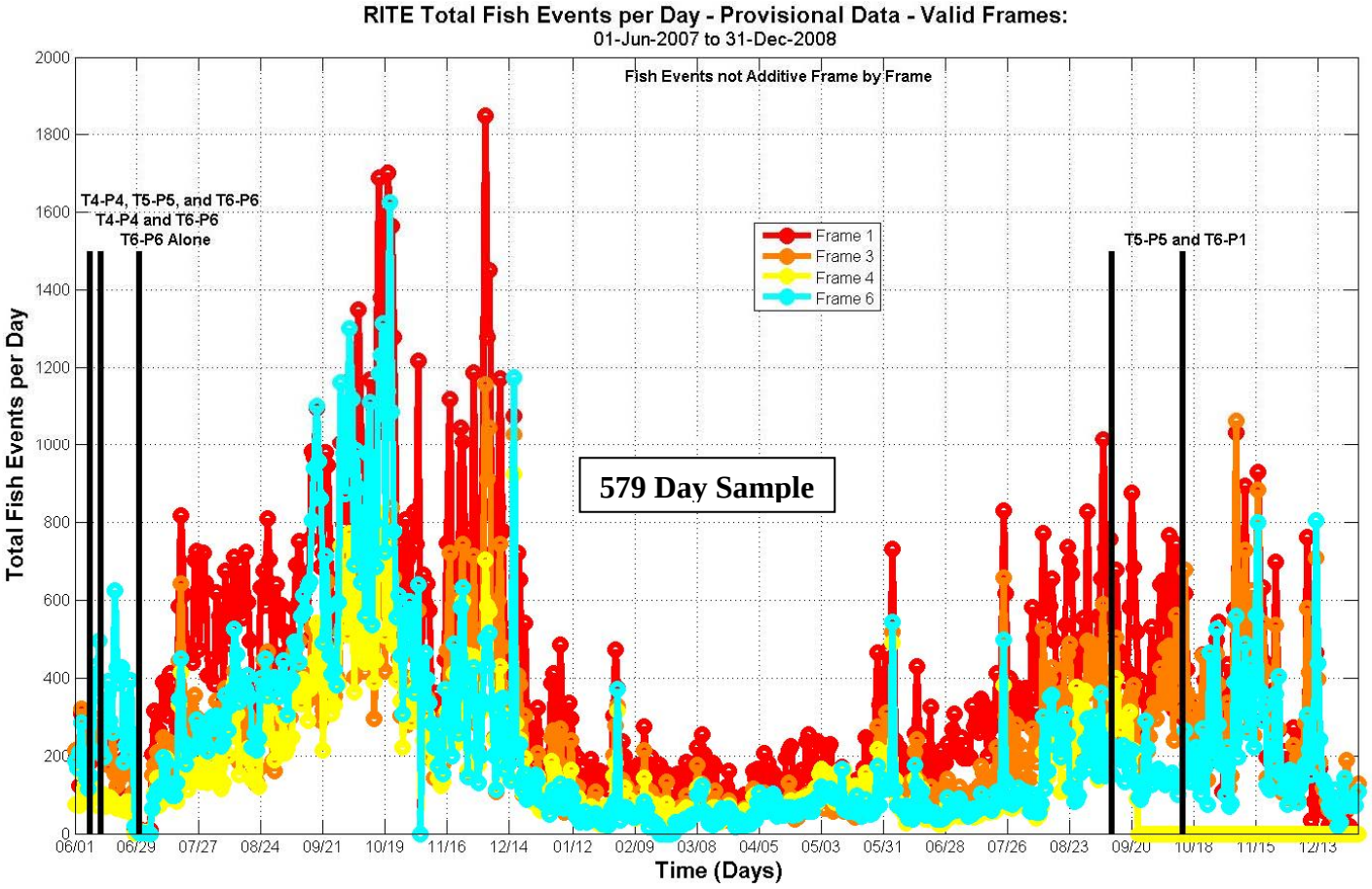
Figure A.3 RITE Project Fish Abundance June 2007 – October 2009 (2 Frames)



**** Presented in "RITE Project status and update" Memorandum via email dated 11/5/09***

This plot shows total fish targets (events) per day for four fish frames from June 1st, 2007 to December 31st, 2008. ***This figure clearly confirms the distinct late fall fish run and the low abundance of fish during the spring and summer.*** Deployment 2 and 3 details are highlighted.

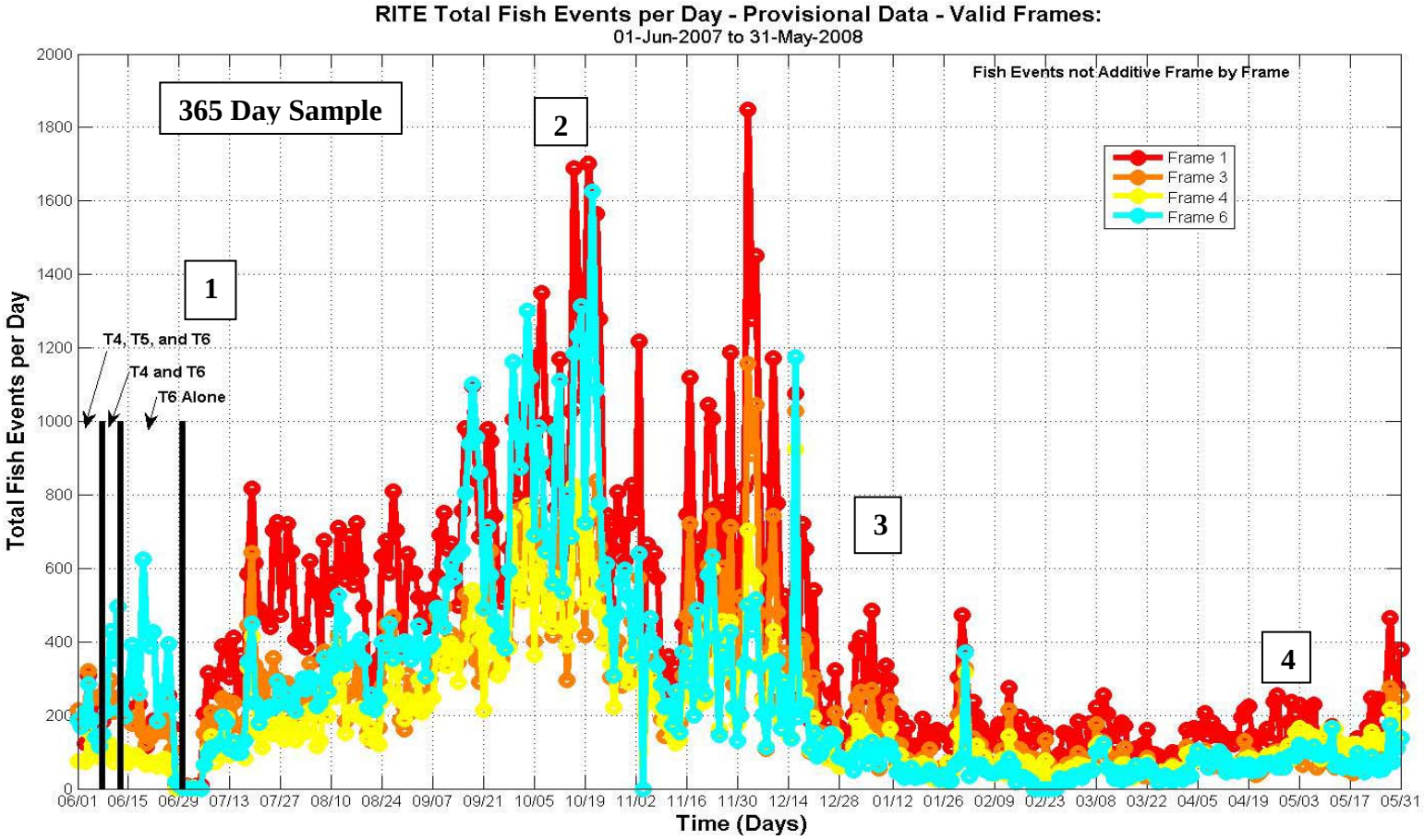
Figure A.4 RITE Project Fish Abundance June 2007 – December 2008 (4 Frames)



**** Presented in "FERC Draft License Application – Volume 2 – Exhibit E"***

This plot shows total fish targets (events) per day for four fish frames. ***This figure clearly reinforces the significance of the fall run (and the relative insignificance of the spring population).*** The notation of 4 time frames on the plot represent 3-day periods selected for further detailed analysis in the figures below.

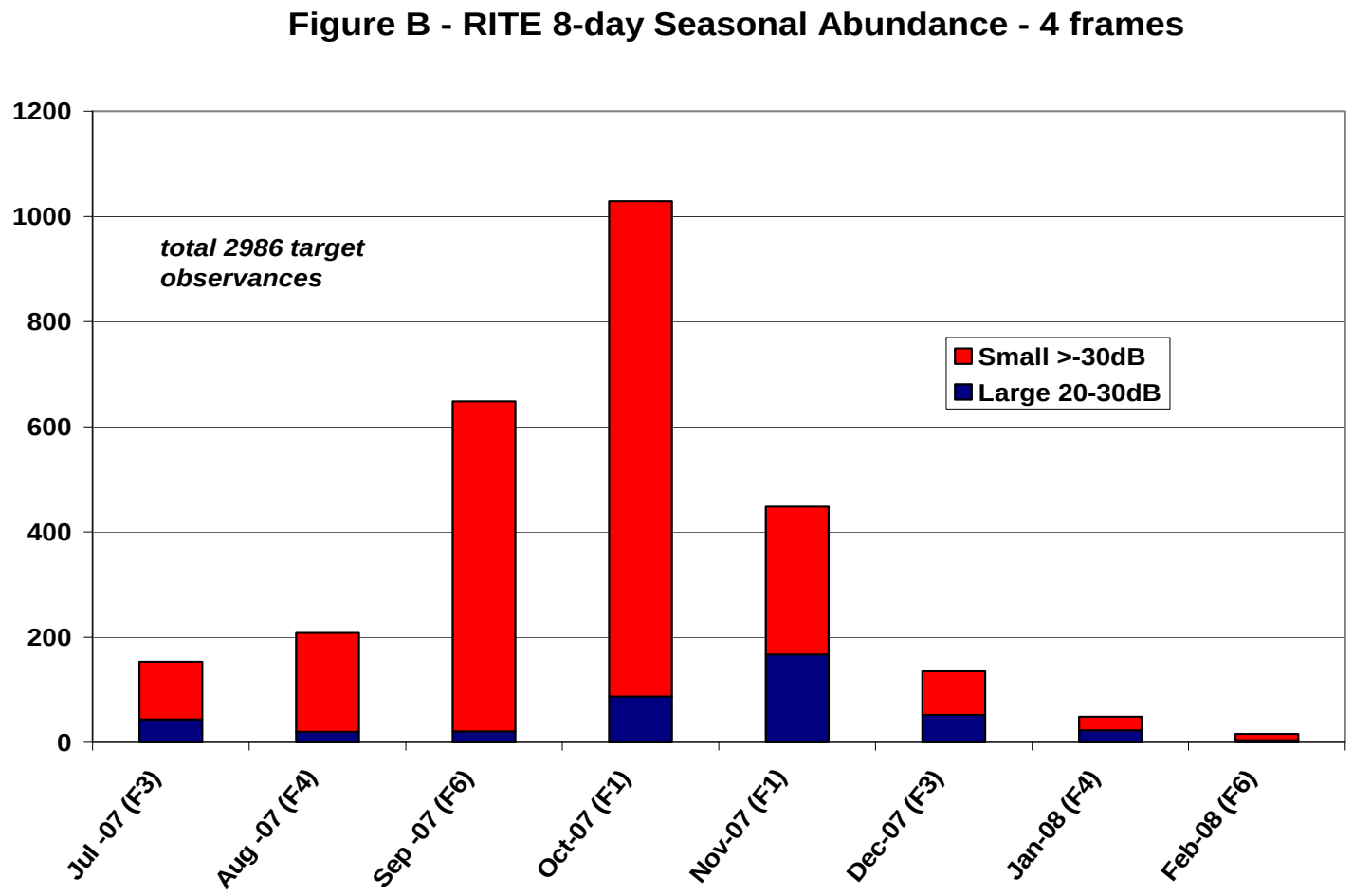
Figure A.5 RITE Project Fish Abundance June 2007 – May 2008 (4 Frames)



**** Presented in "FERC Draft License Application – Volume 2 – Exhibit E"***

This figure shows the relative seasonal abundance of small, < 30', and large, >30', fish based on 8 single days of data taken from 8 consecutive months. More than 70% of all observations occurred in September through November, further evidence of the annual fall run.

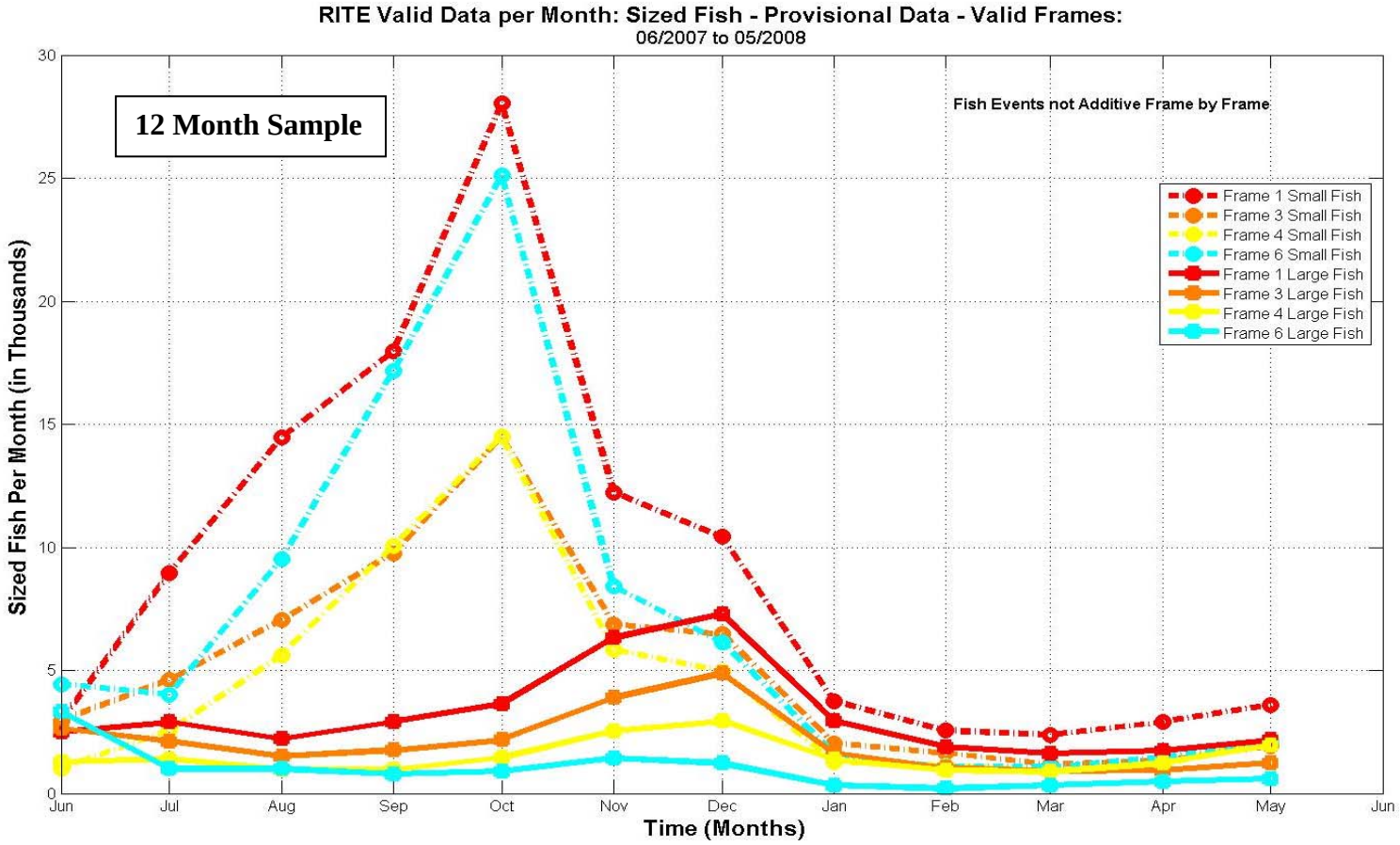
Figure A.6 RITE Project Seasonal Abundance vs. Size – 1 Day for 8 Months (4 Frames)



**** Presented in "Attachment A RITE FMPP Fixed Hydroacoustics DATA"***

This plot shows a comparison of small (<30') and large (>30') fish by month for four fish frames. This figure clearly identifies the lack of abundance of small or large fish in the spring and the passage of small fish followed by larger fish in the late fall run, seen in Figure A.6 above as well. This behavior is captured well in all four fish frames, with a predominance of total fish to the south (see Figure A.1).

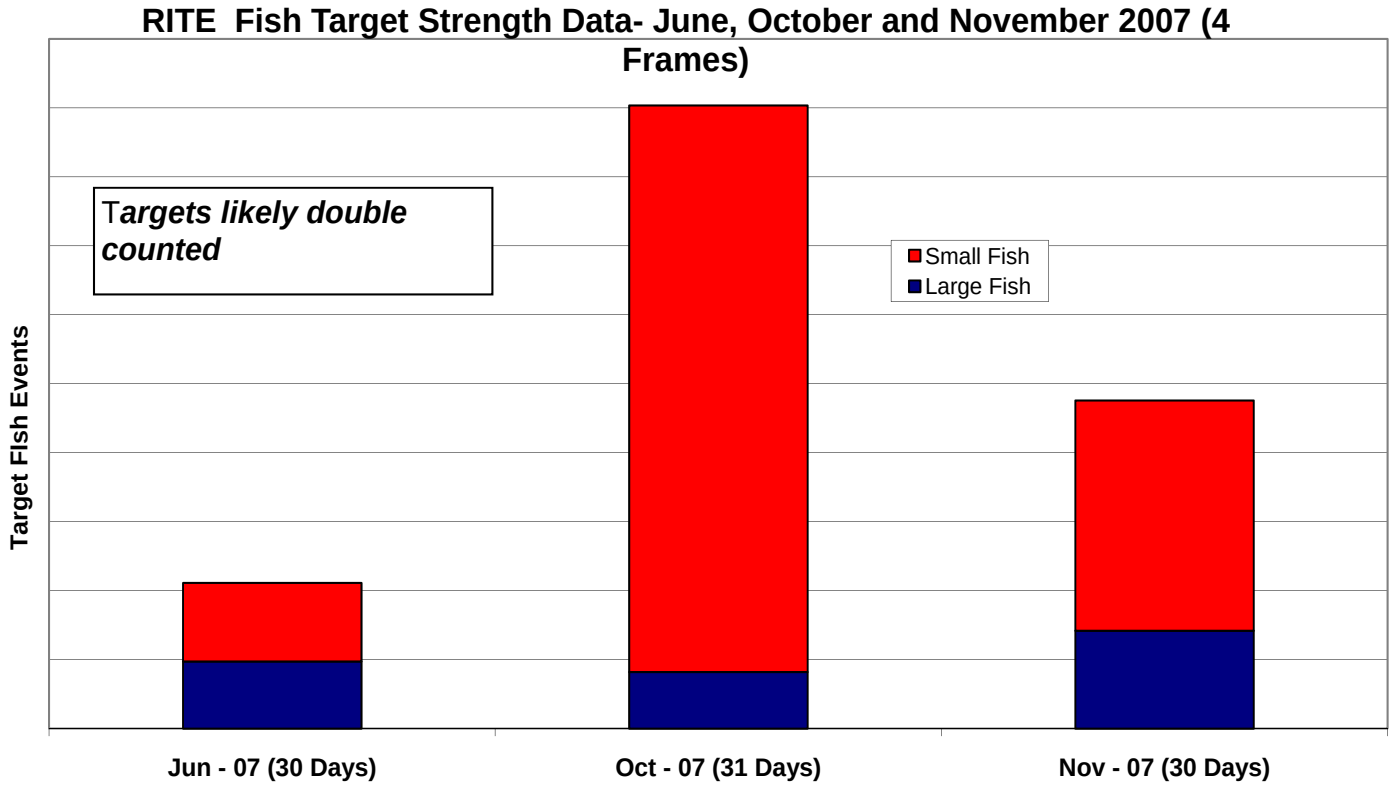
Figure A.7 RITE Project Comparison of Small and Large Fish Targets June 2007 – May 2008 (4 Frames)



**** Presented in "FERC Draft License Application – Volume 2 – Exhibit E"***

This figure presents similar data as Figures A.6 and A.7 above. However, the monthly sum of fish from four frames for 3 relevant months is presented for both small (<30') and large (>30') fish. The multifold increase in total fish abundance in October is clear, as is the rise in relative large fish abundance in November and the relative rise in small fish abundance in October, seen throughout the data record.

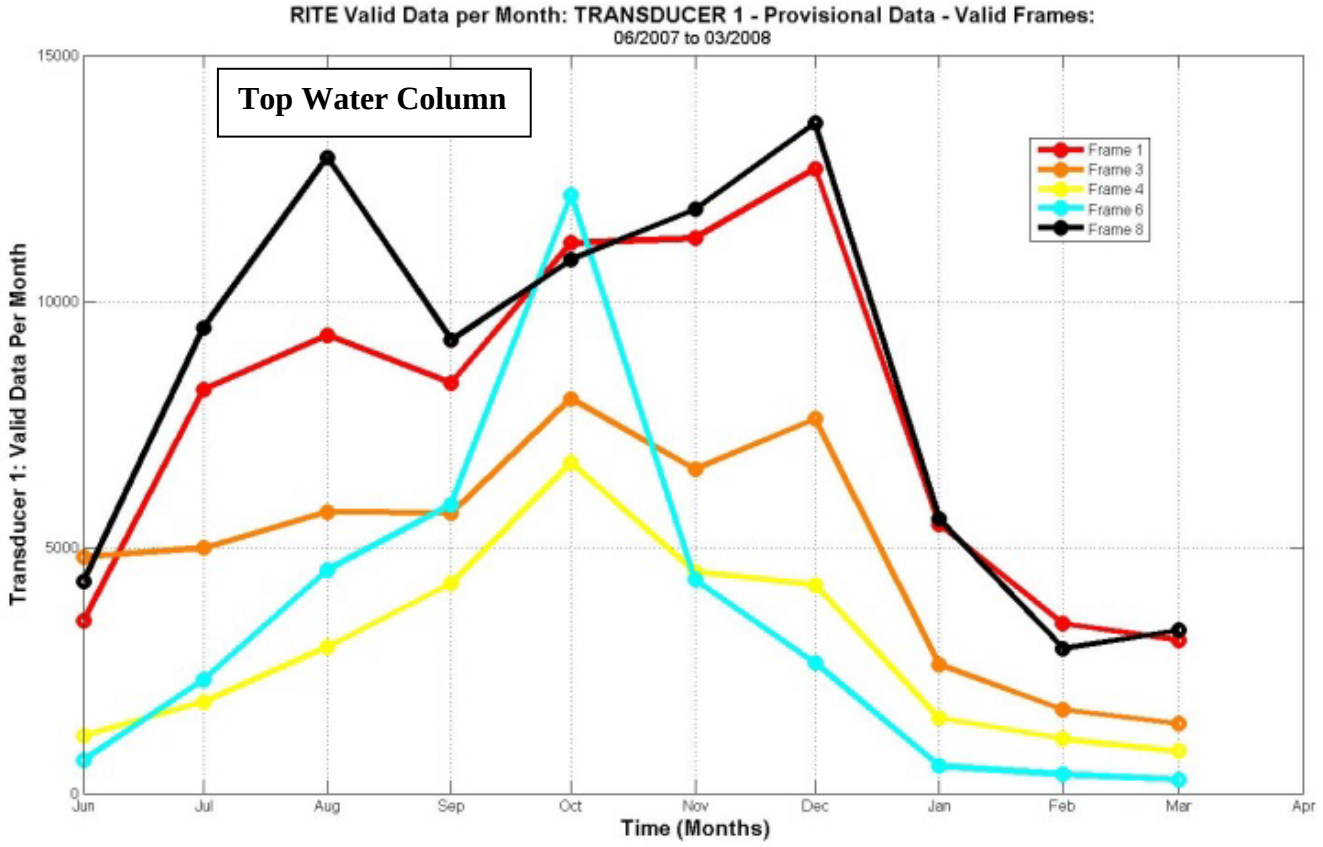
Figure A.8 RITE Project Small Fish vs. Large Fish – 3 Months (4 Frames)



**** Presented in "FERC Draft License Application – Volume 2 – Exhibit E"***

This plot shows the presence of fish within the top portion of the water column during 10 consecutive months centered on the fall migration. Comparison with Figures A.9-II and A.9-III confirms that most fish are detected in the top of the water column. The absence of fish in February and March agrees well with previous discussion, however, Frames 1 and 8 suggest a more uniform distribution in late summer.

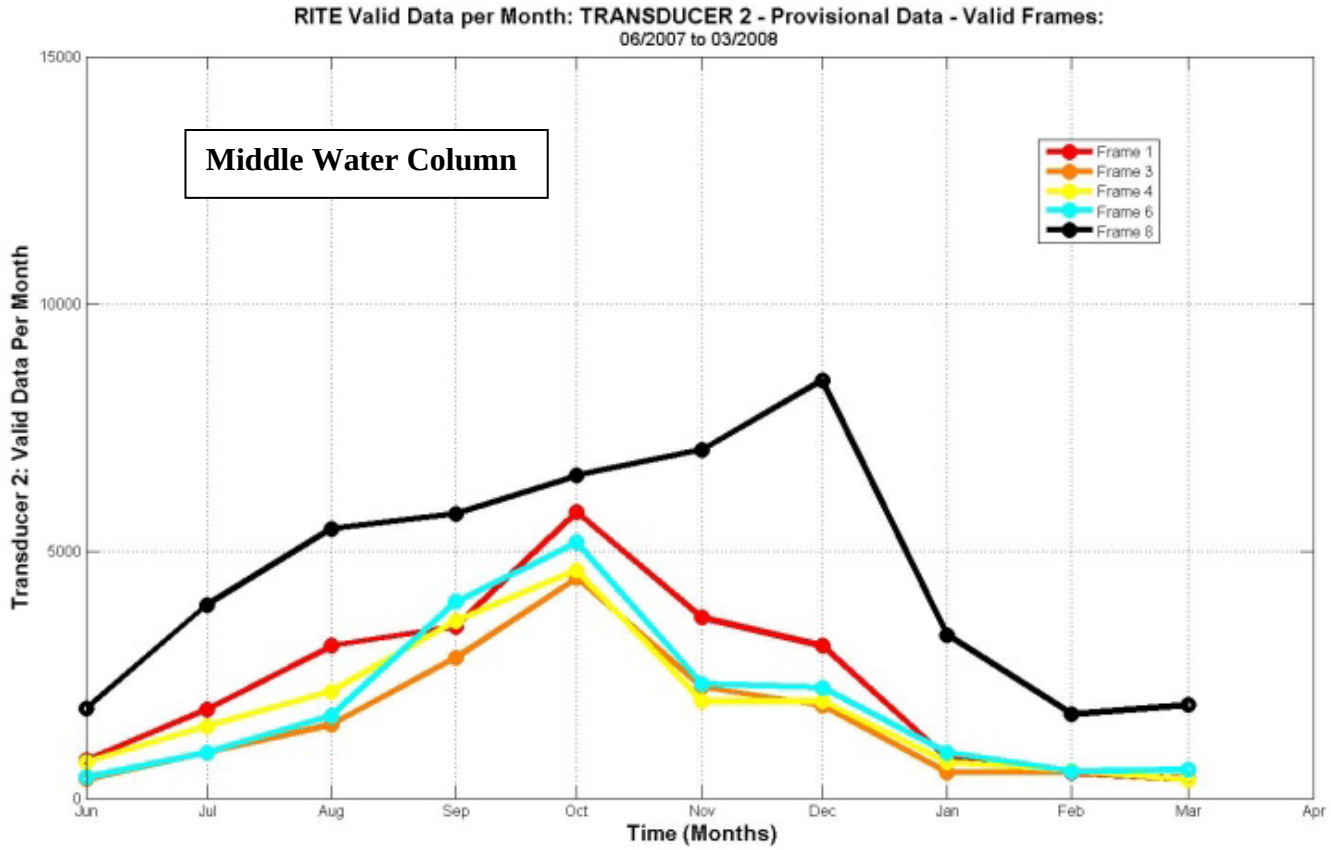
Figure A.9-I RITE Project Seasonal Fish Abundance Top Water Column June 2007 – March 2008 (5 Frames)



**** Presented for Final License Application***

This plot shows the presence of fish within the middle portion of the water column during the same period as Figure A.9-I and A.9-III. Comparison with those figures confirms that the fewest fish are observed in the middle of the water column during all 10 months for most of the frames. The seasonal variation in fish abundance is clear, including the surge in fish at mid-water column in Frame 8 in December.

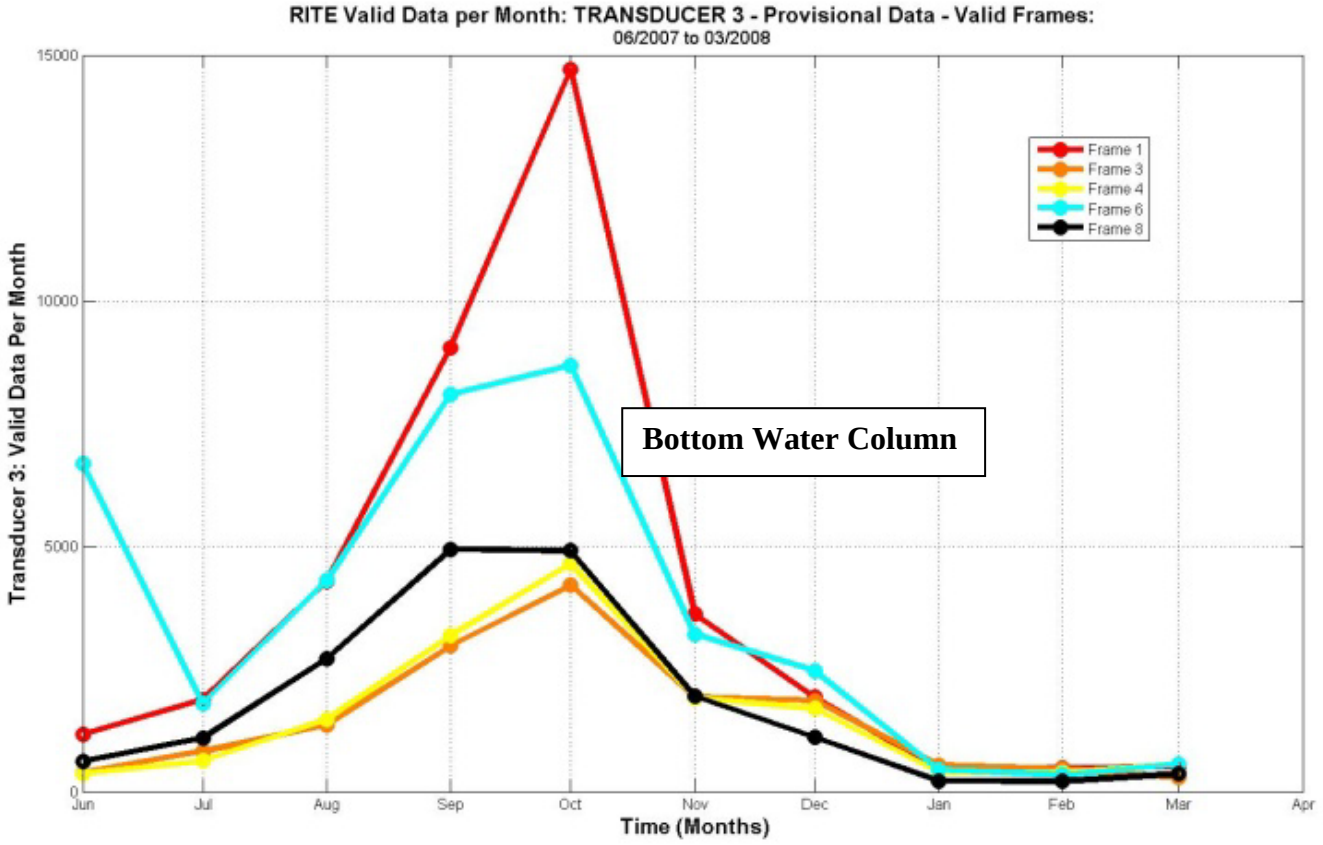
Figure A.9-II RITE Project Seasonal Fish Abundance Middle Water Colum June 2007 – March 2008 (5 Frames)



**** Presented for Final License Application***

This plot shows the presence of fish within the bottom portion of the water column during the same period as Figure A.9-I and A.9-II. The seasonal variation in fish abundance is clear for all frames, including the main surge in fish seen in September and October followed by a smaller pulse of fish seen in November and December. The increase in fish abundance relative to the mid-water column is also clear.

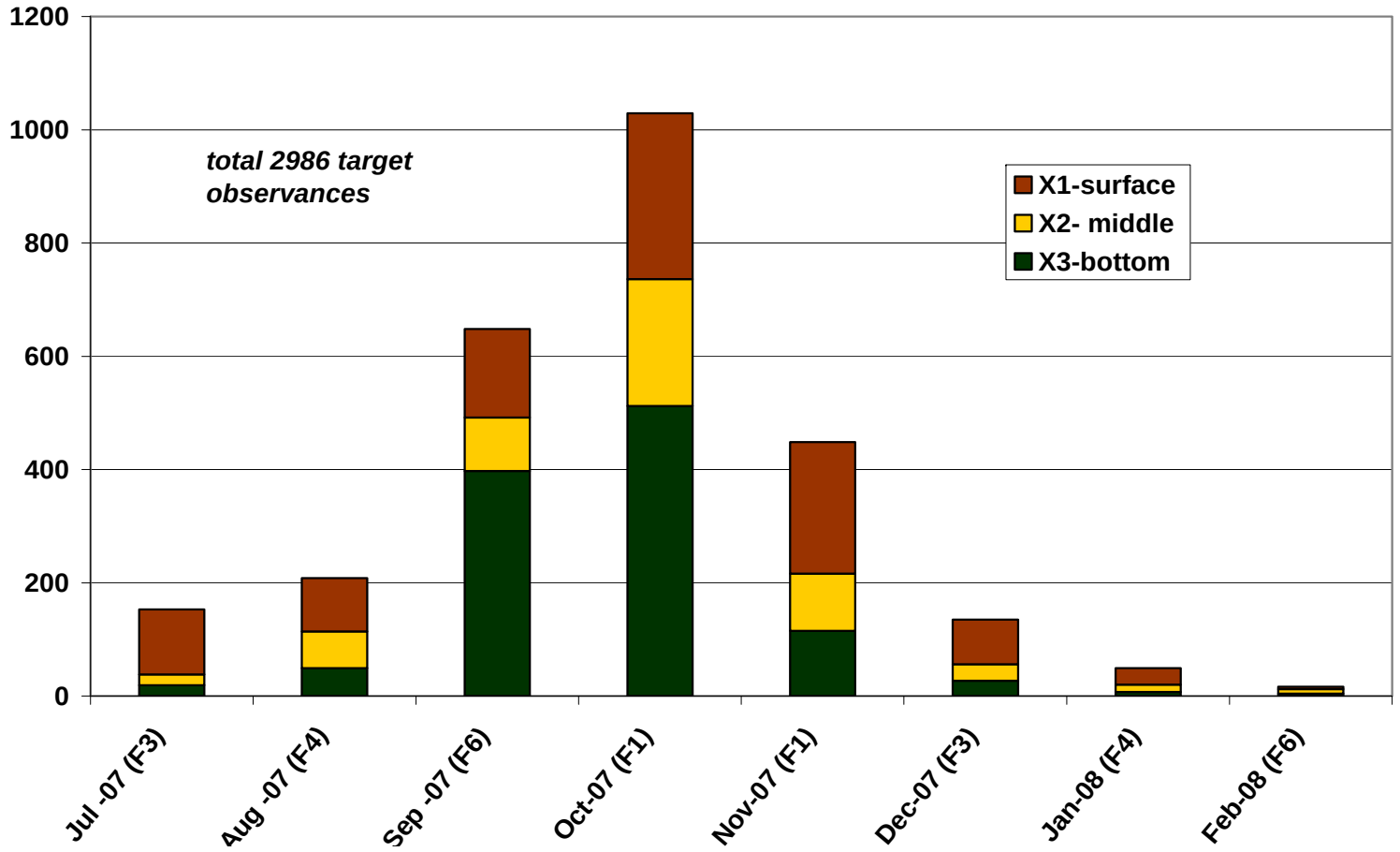
Figure A.9-III RITE Project Seasonal Fish Abundance Bottom Water Column June 2007 – March 2008 (5 Frames)



**** Presented for Final License Application***

This figure compares the distribution of fish within the water column based on 8 single days of data taken from 8 consecutive months, similar to Figure A.6 above. As previously, very few fish populate the middle of the water column, instead preferring the top and bottom of the water column. This trend holds true during the fall migration and during low abundance periods.

Figure A.10 RITE Project Seasonal Abundance vs. Depth – 1 Day for 8 Months (4 Frames)



**** Presented in "Attachment A RITE FMPP Fixed Hydroacoustics DATA"***

These plots depict fish movement in both direction (N/S) and swim speed in relation to the tidal speed.

At the NYSDEC direction, we selected two 3-day periods (June 2007 and March 2008) to depict with and without KHPS operation and two periods at peak distribution (October 2007 and November 2007). ***Not surprisingly fish have a strong movement on the transition from ebb to slack to flood, and vice versa (nearly vertical scatter patterns as shown in red).*** This is consistent in the representative June period (Figure A.11) and the representative peak Period 3 (December) (Figure A.12). The four time periods examined are identified in Figure A.5 and given below:

- Period 1: 6/14, 6/15, 6/16 (2007) – Around 200 fish targets (events) per day
- Period 2: 10/20, 10/21, 10/22 (2007) – Peak Around 1600 fish targets (events) per day
- Period 3: 12/3, 12/4, 12/5 (2007) – Peak Around 1800 fish targets (events) per day
- Period 4: 3/7, 3/8, 3/9 (2008) – Around 200 fish targets (events) per day

The first plots, Figures A.11-I and A.11-II show only fish in the turbine impact zones moving north (flood) and south (ebb) during a 3-day period. Twenty-nine percent of the fish are observed in the June operational period in these zones and 18% in the December peak period.

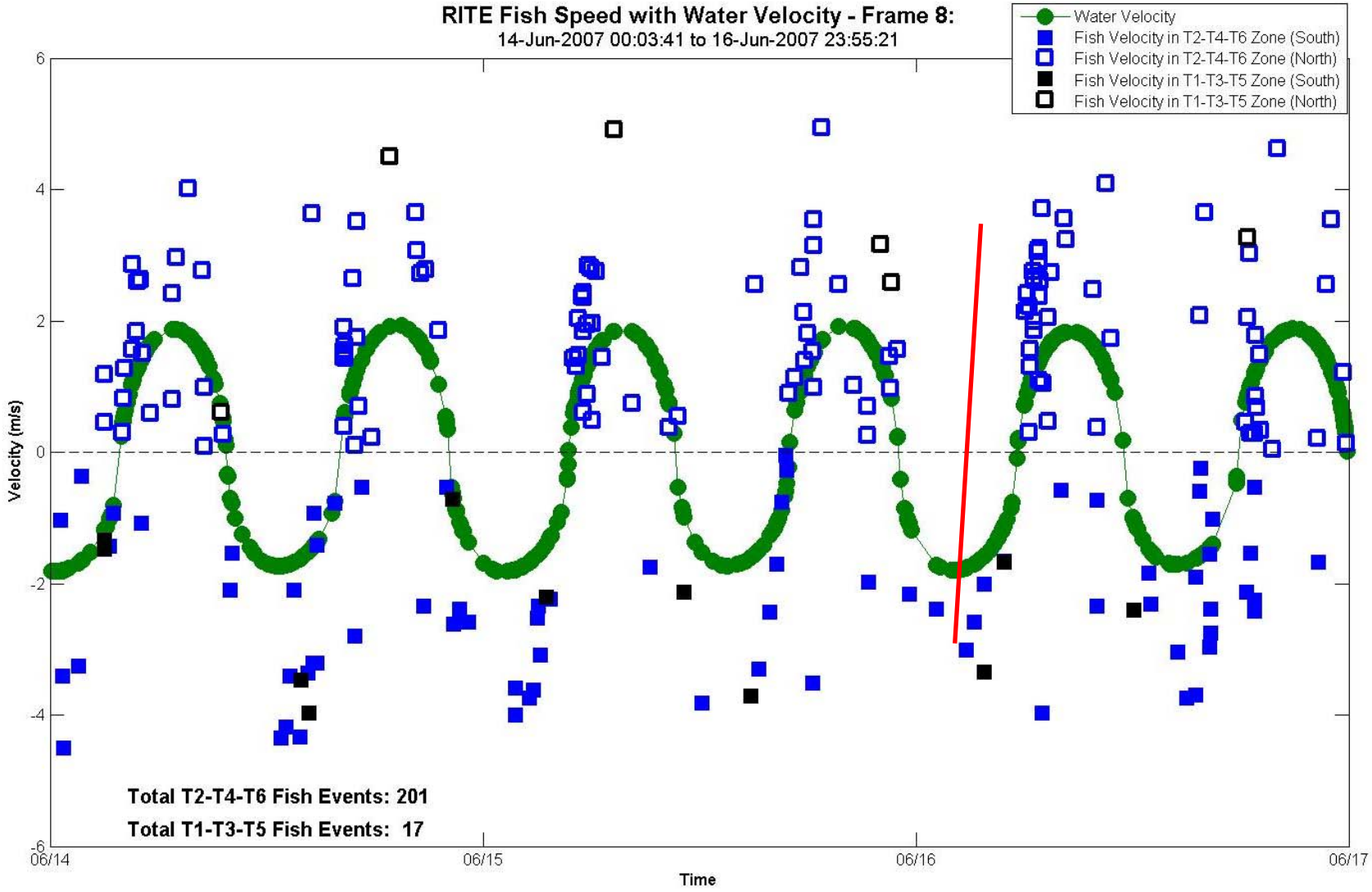
The second plots, Figures A.12-I and A.12-II summarizes fish in both impact and non-impact zones during the same period. Fish movement is observed with the tide in terms of direction. Several interesting observations:

- Strong movement on the transitional operational period (when KHPS are not operating)
- Fish targets observed swimming faster than tidal velocity
- <30% of targets are observed in turbines zones; less in peak periods.

- A strong southerly movement, representing high density or possible migration was observed in December 2007 as shown of Figures A.3 – A.7 and Figure A.12.

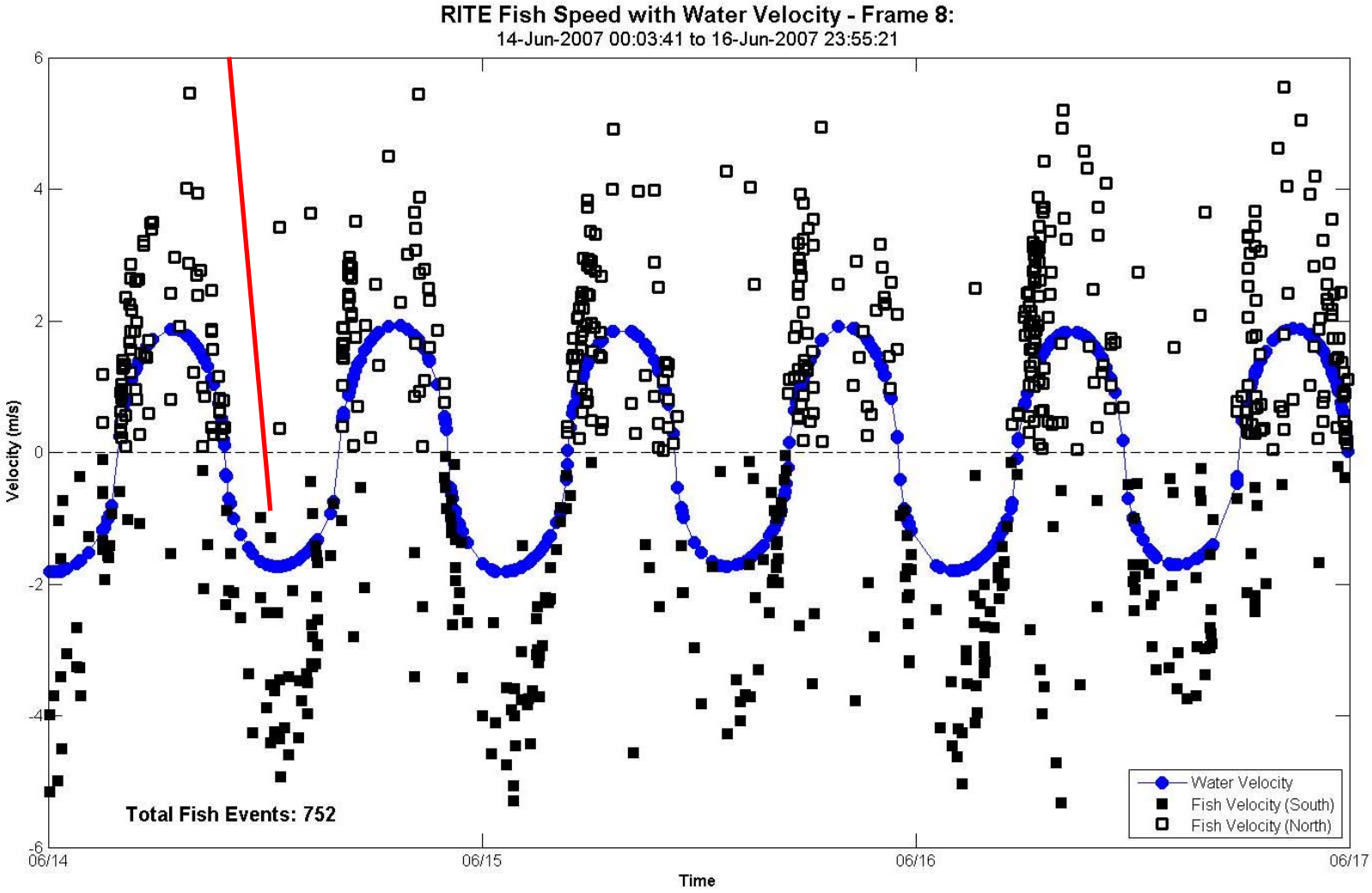
Note: Figures A.10 and A.11 represent three consecutive days of data.

Figure A.11-I RITE Project Fish Targets in Turbine Zones Only (~29%) – June 14-16, 2007 (Frame 8)



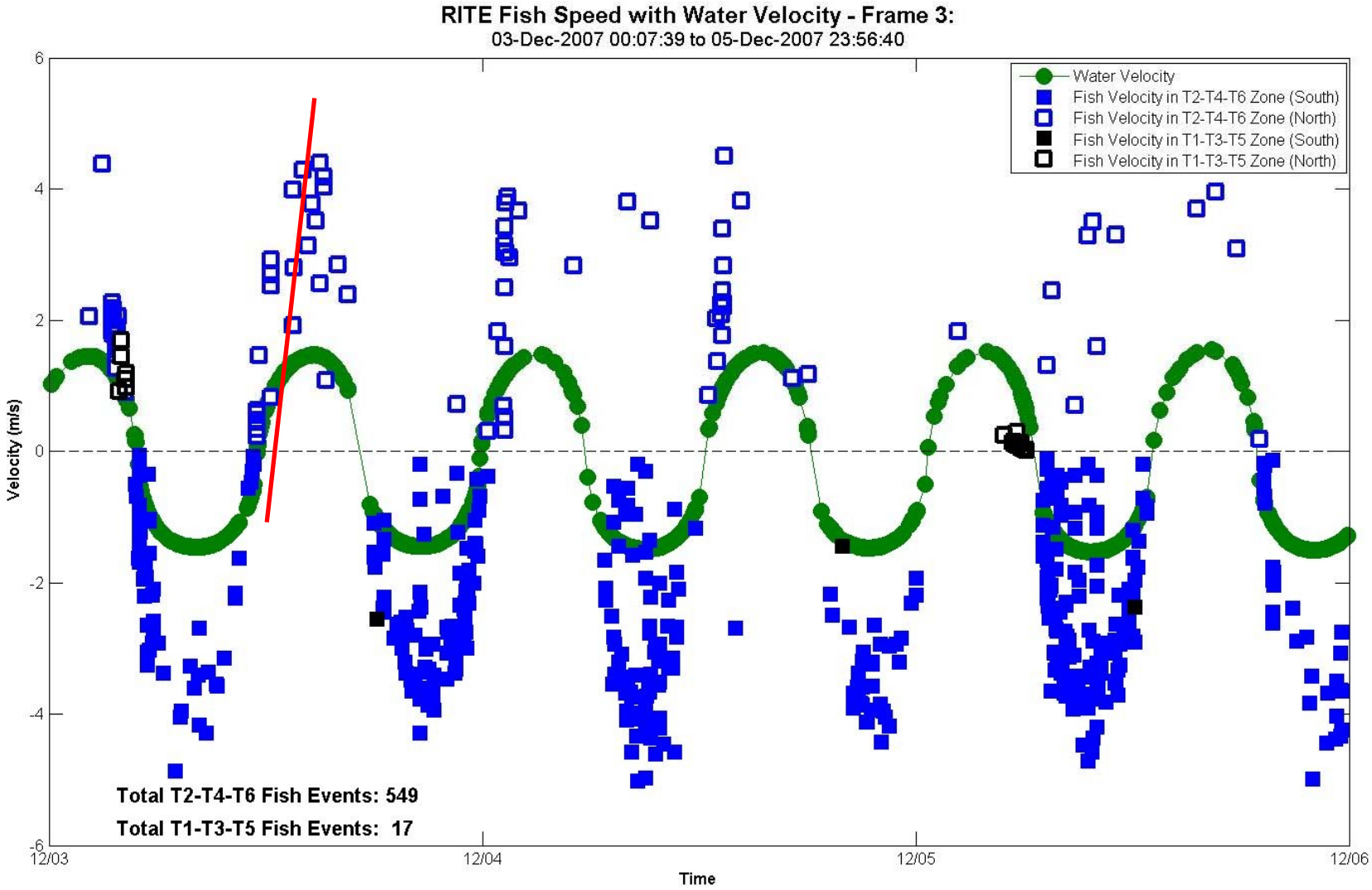
**** Presented in "FERC Draft License Application – Volume 2 – Exhibit E"***

Figure A.11-II RITE Project Fish Targets in all Zones (100%) – June 14-16, 2007 (Frame 8)



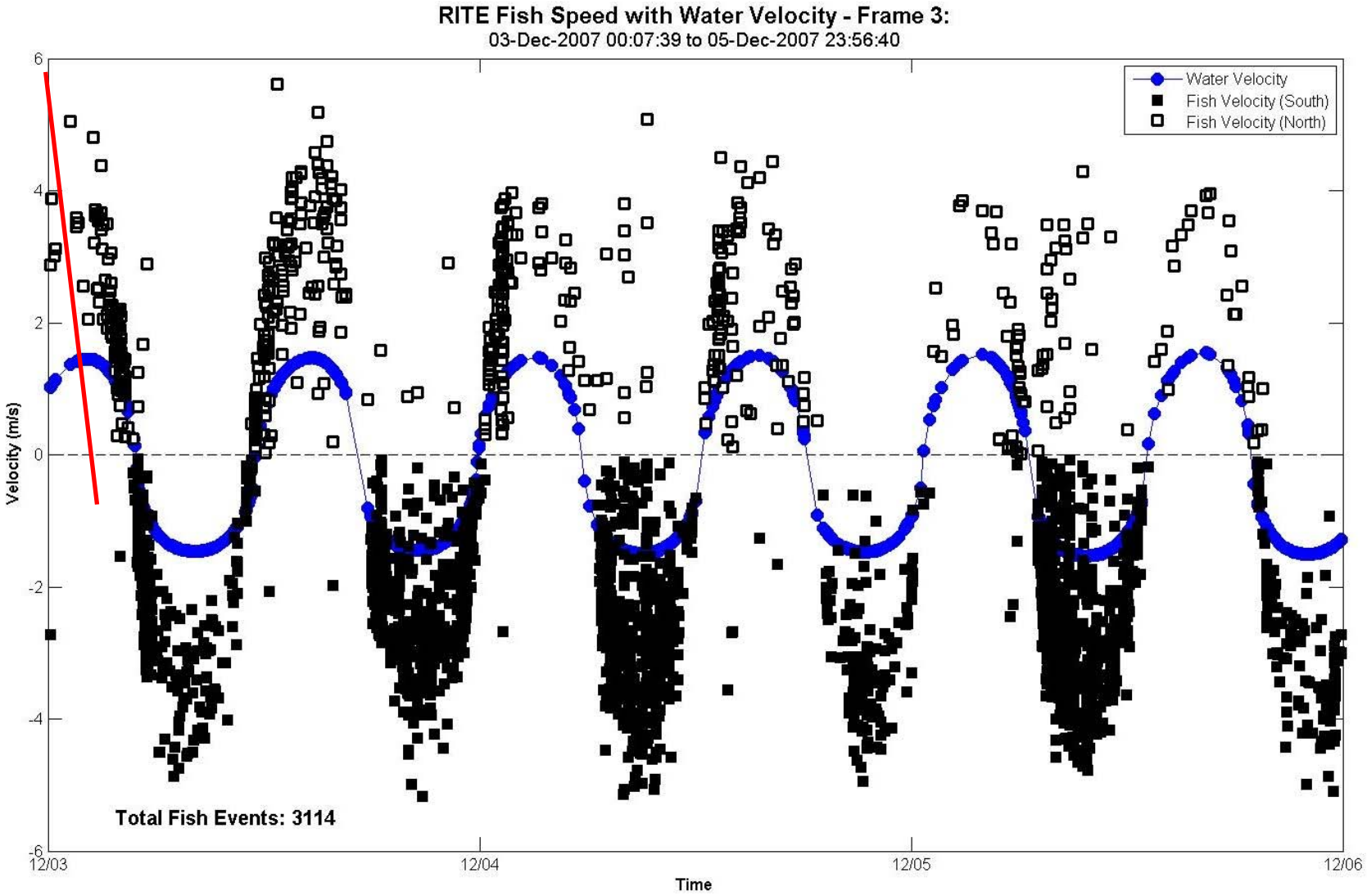
**** Presented in "FERC Draft License Application – Volume 2 – Exhibit E"***

Figure A.12-I RITE Project Fish Targets in Turbine Zones Only (~18%) – December 3-5, 2007 (Frame 3)



**** Presented in "FERC Draft License Application – Volume 2 – Exhibit E"***

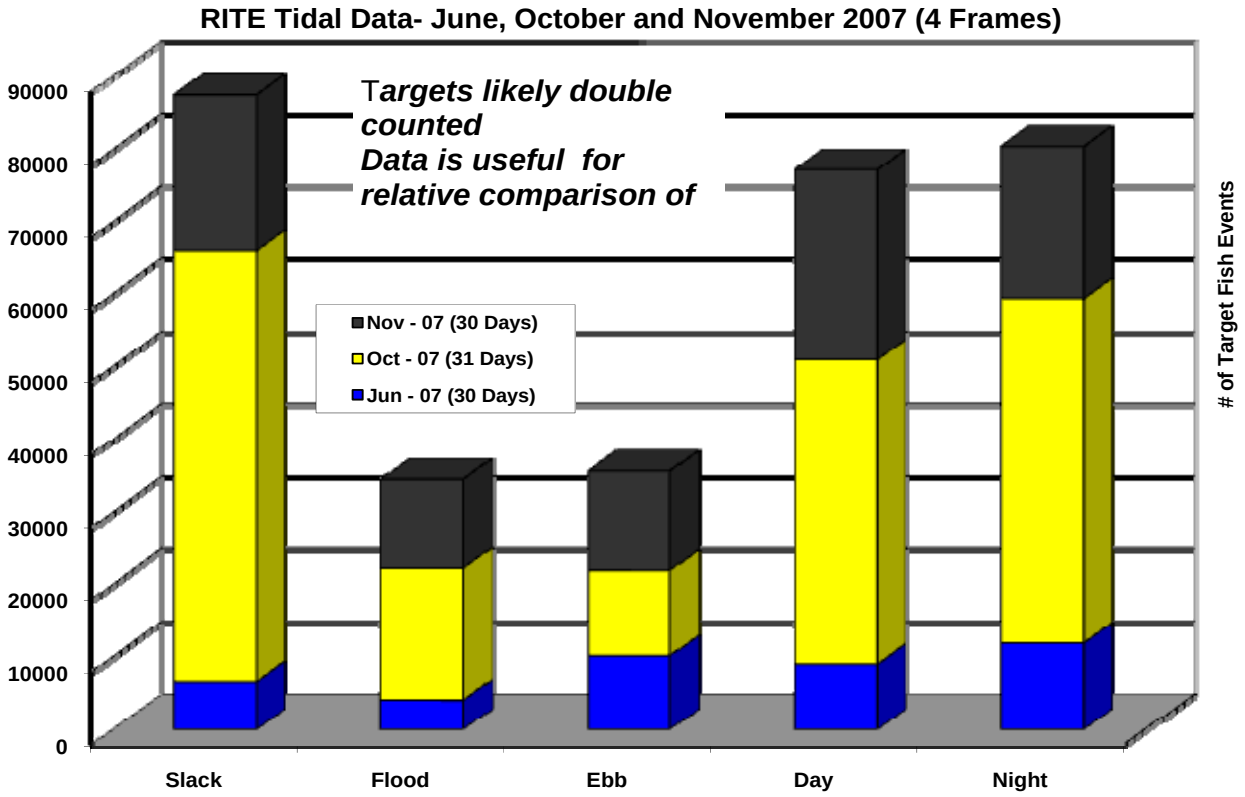
Figure A.12-II RITE Project Fish Targets in all Zones (100%) – December 3-5, 2007 (Frame 3)



**** Presented in "FERC Draft License Application – Volume 2 – Exhibit E"***

This figure presents the monthly sum of fish from four frames for 3 relevant months for flood/ebb/slack and night/day. The multifold increase in total fish abundance in October is clear, as is the dominant abundance of fish observed during slack tide. There is no clear trend in fish observation between night and day, suggesting a uniform distribution throughout a solar cycle, unlike a lunar cycle.

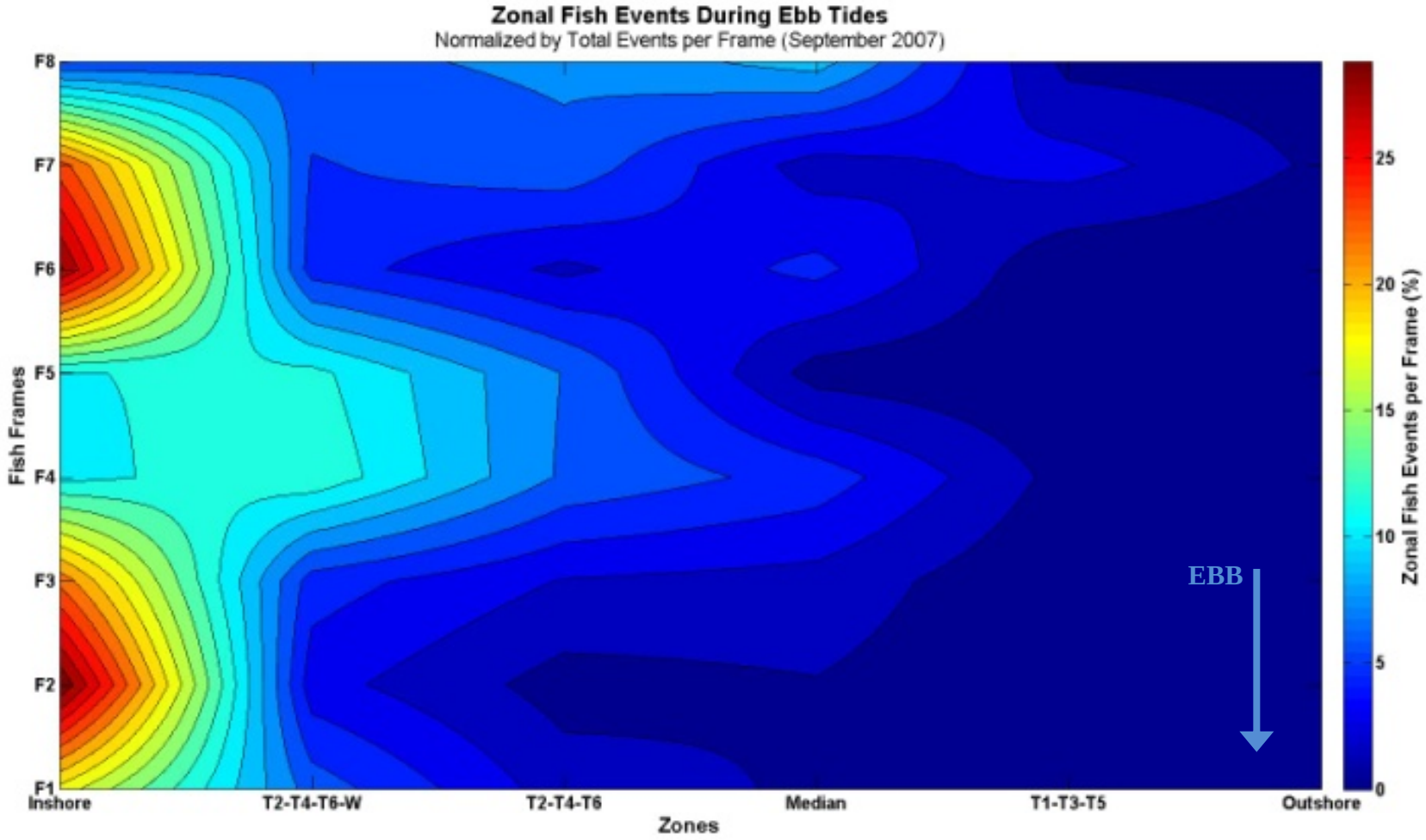
Figure A.13 RITE Project Abundance during Tidal and Day/Night Cycles – 3 Months (4 Frames)



**** Presented in "FERC Draft License Application – Volume 2 – Exhibit E"***

This contour plot presents a geographic distribution of fish events observed during ebb tides within the RITE demonstration area. There is a clear increase in fish abundance and presence inshore, with an associated absence in the turbine zones and outshore.

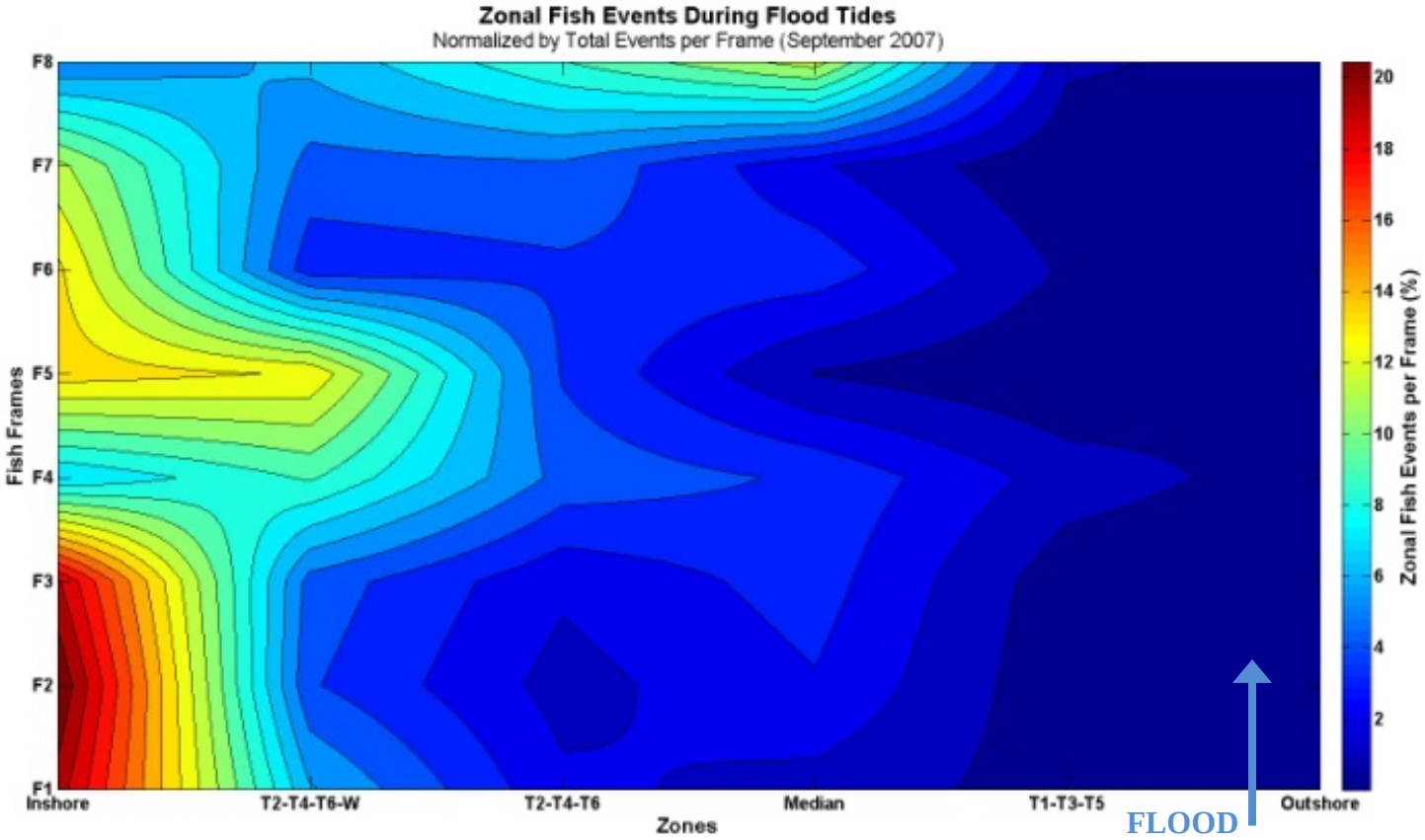
Figure A.14-I RITE Project Monthly Zonal Fish Distribution on an Ebb Tide – September 2007 (All Frames)



**** Presented for Final License Application***

This contour plot presents a geographic distribution of fish events observed during flood tides within the RITE demonstration area. There is a clear increase in fish abundance and presence inshore, with an associated absence in the turbine zones and outshore. The wake created by the Roosevelt Island Bridge west caisson on a flood tide, Figure A.1, may explain the increase in fish abundance inshore to the south.

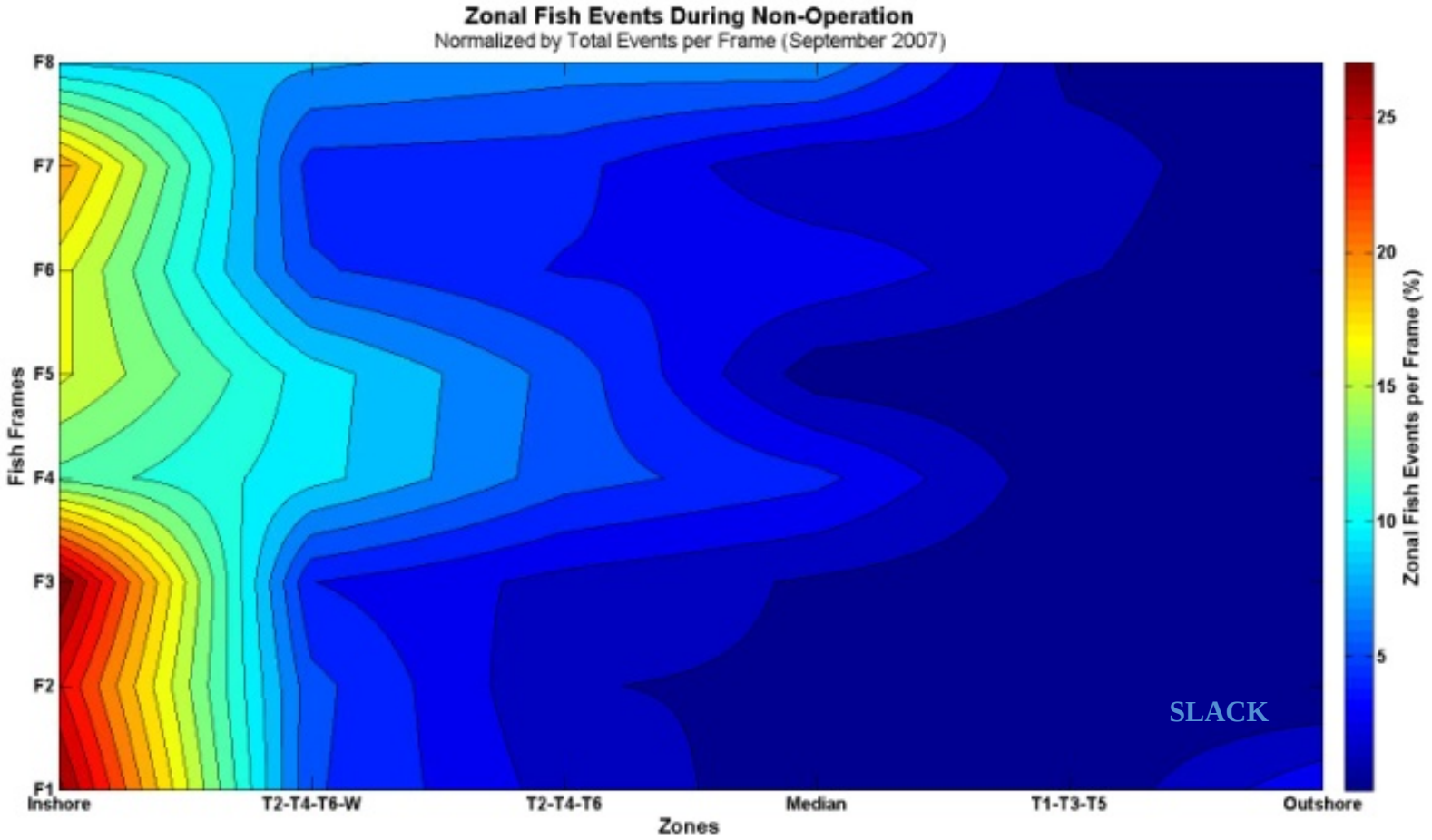
Figure A.14-II RITE Project Monthly Zonal Fish Distribution on a Flood Tide – September 2007 (All Frames)



**** Presented for Final License Application***

This contour plot presents a geographic distribution of fish events observed during slack tides within the RITE demonstration area. Again, there is a clear increase in fish abundance and presence inshore during slack, with a similar absence in the turbine zones and outshore.

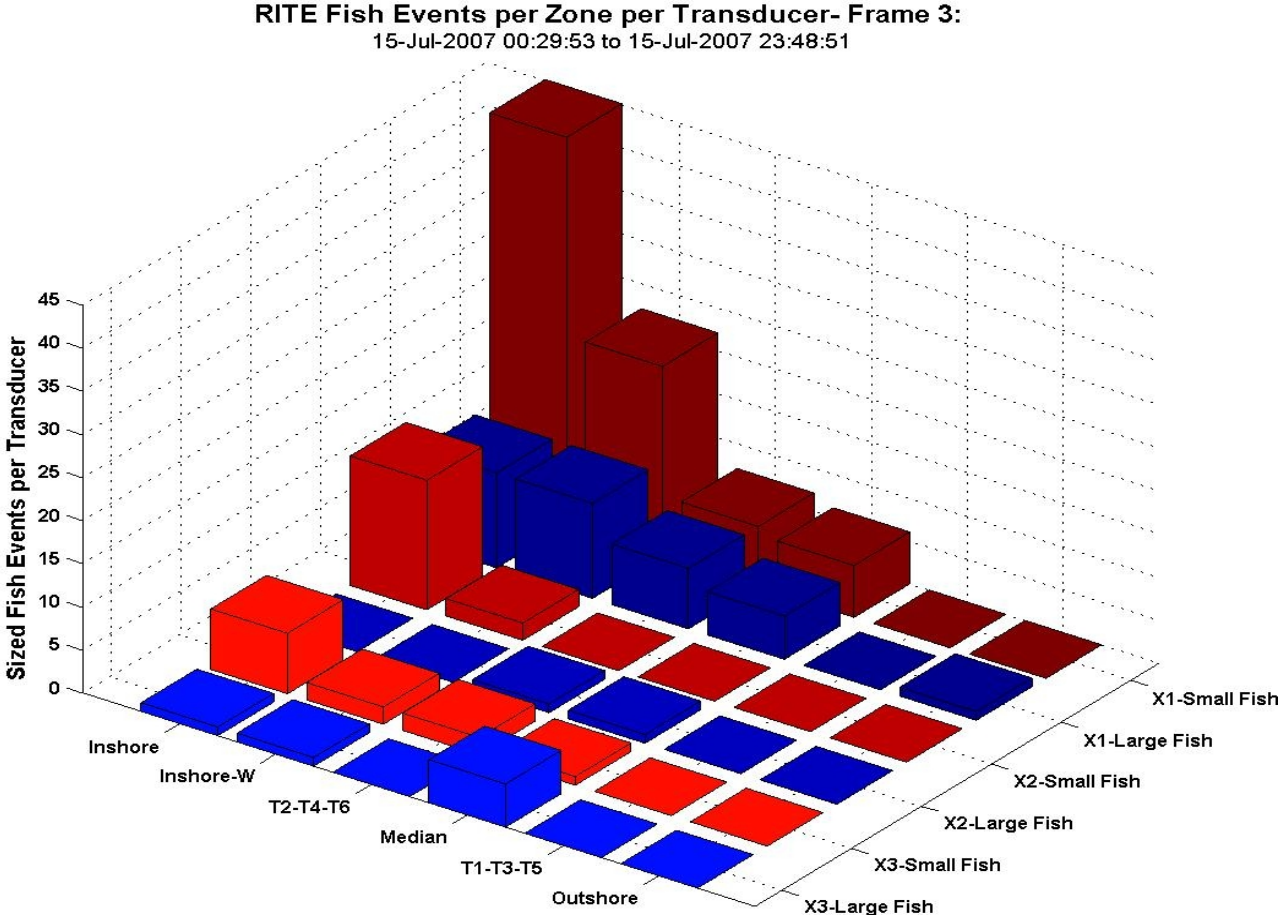
Figure A.14-III RITE Project Monthly Zonal Fish Distribution on a Slack Tide – September 2007 (All Frames)



**** Presented for Final License Application***

This figure presents a similar spatial representation of fish abundance as Figures A.14-I through A.14-III, however, only a single fish frame during a 24-hour period in July is shown, sorted by location in the water column. As previously, the vast majority of fish are located inshore, away from the turbine zones. Further, most fish are seen in the top of the water column, in agreement with Figures A.9-I and A.10

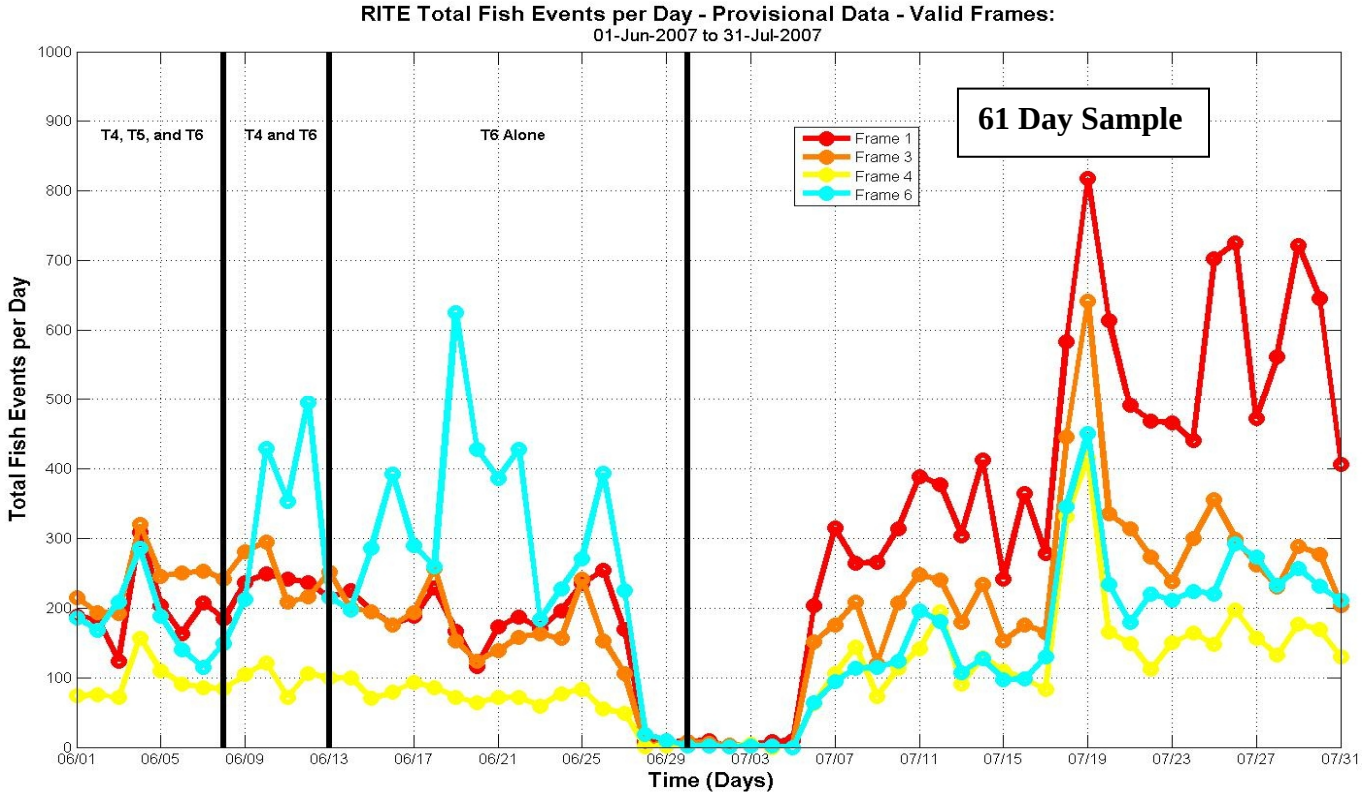
Figure A.15 RITE Project Fish distribution: Zonal, Depth, Size – July 15, 2007 (Frame 3)



**** Presented in "Attachment A RITE FMPP Fixed Hydroacoustics DATA"***

This plot details the low abundance through the two months when T4, T5, and T6 were partially operating (and failing) and the following month for comparison. The loss of data at the end of June/early July reflects a power outage that was restored on July 5. We believe that Frame 6 erroneously "counted" fish when T5 and T6, see Figure A.1, were failing in the later part of June, since Frame 6 exhibits significantly different behavior after July 2007 (see Figures A.3 – A.5 and Figure A.9-III). This "noise" issue is an acknowledged limitation of the fixed hydroacoustic system in this environment.

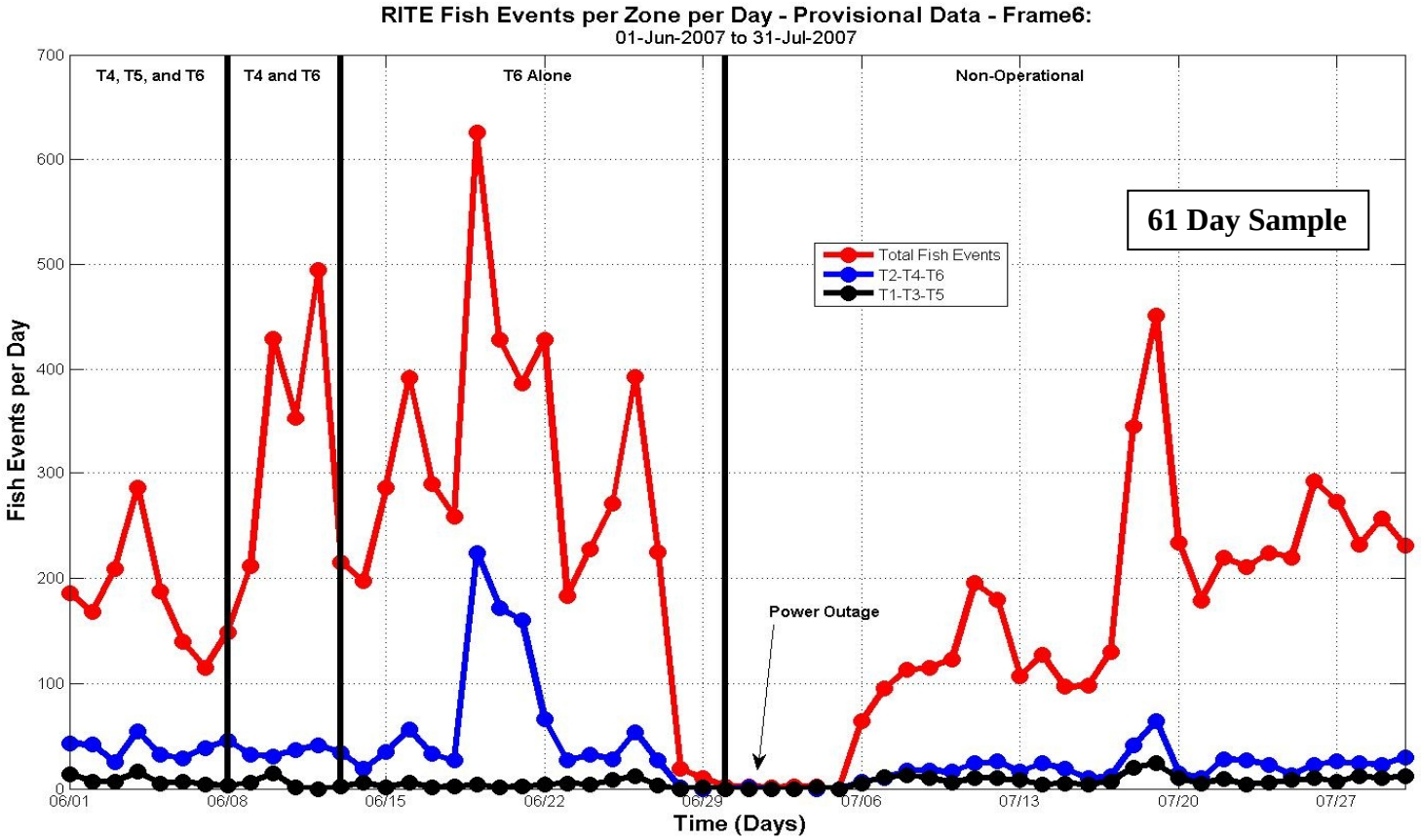
Figure A.16 RITE Project Fish Abundance during KHPS Deployment 2 and Afterwards – June and July 2007 (4 Frames)



**** Presented in "FERC Draft License Application – Volume 2 – Exhibit E"***

This plot shows June and July fish events, similar to Figure A.16 above, for a single frame, Frame 6. All fish targets (Red) are shown with fish targets observed in the two impact zones, Zone 1 (T2-T4-T6 – Blue) and Zone 2 (T1-T3-T5 - Black). The relevance here is that very few fish tracks are observed in the zones occupied by the turbines. This behavior pattern is consistent throughout the data history.

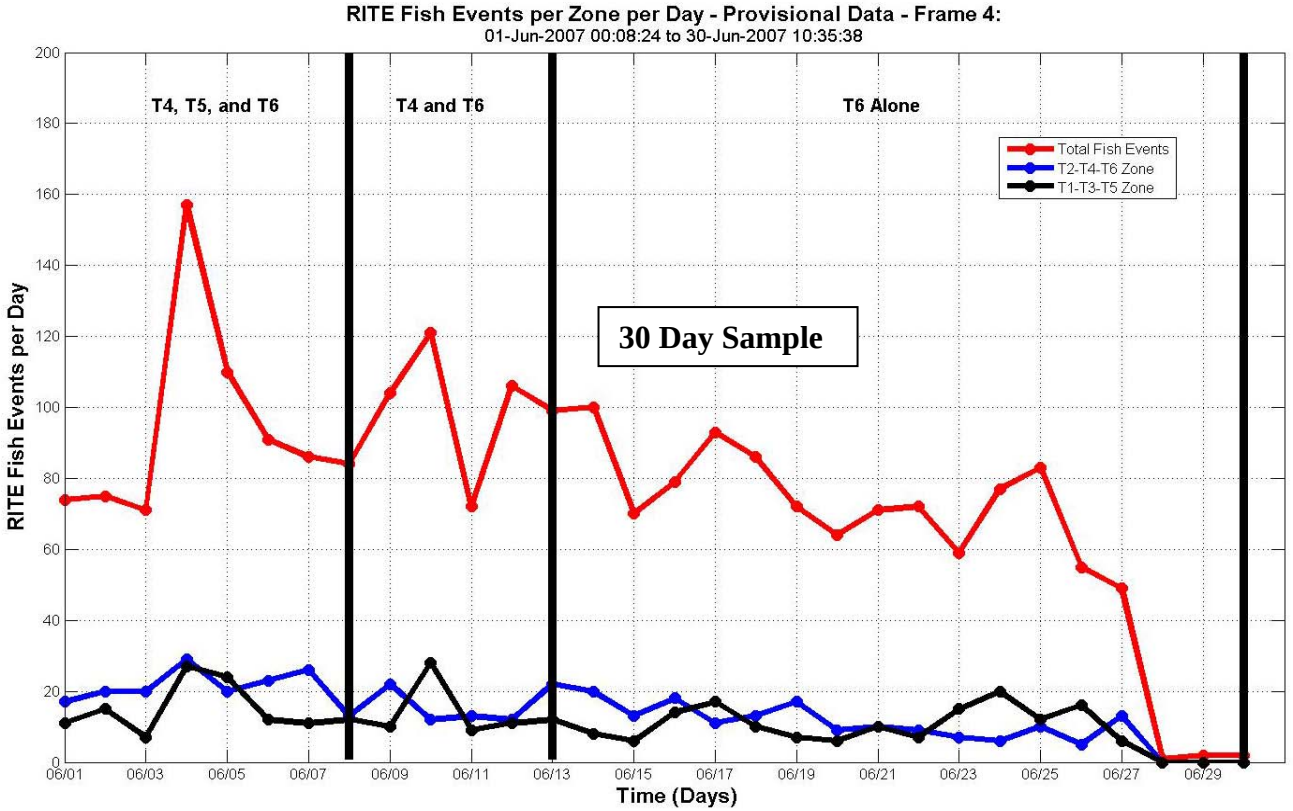
Figure A.17 RITE Project Total and Impact Zone Fish Targets during Deployment 2 and Afterwards: Zone 1 (T2-T4-T6) and Zone 2 (T1-T3-T5) – June and July 2007 (Frame 6)



**** Presented in "FERC Draft License Application – Volume 2 – Exhibit E"***

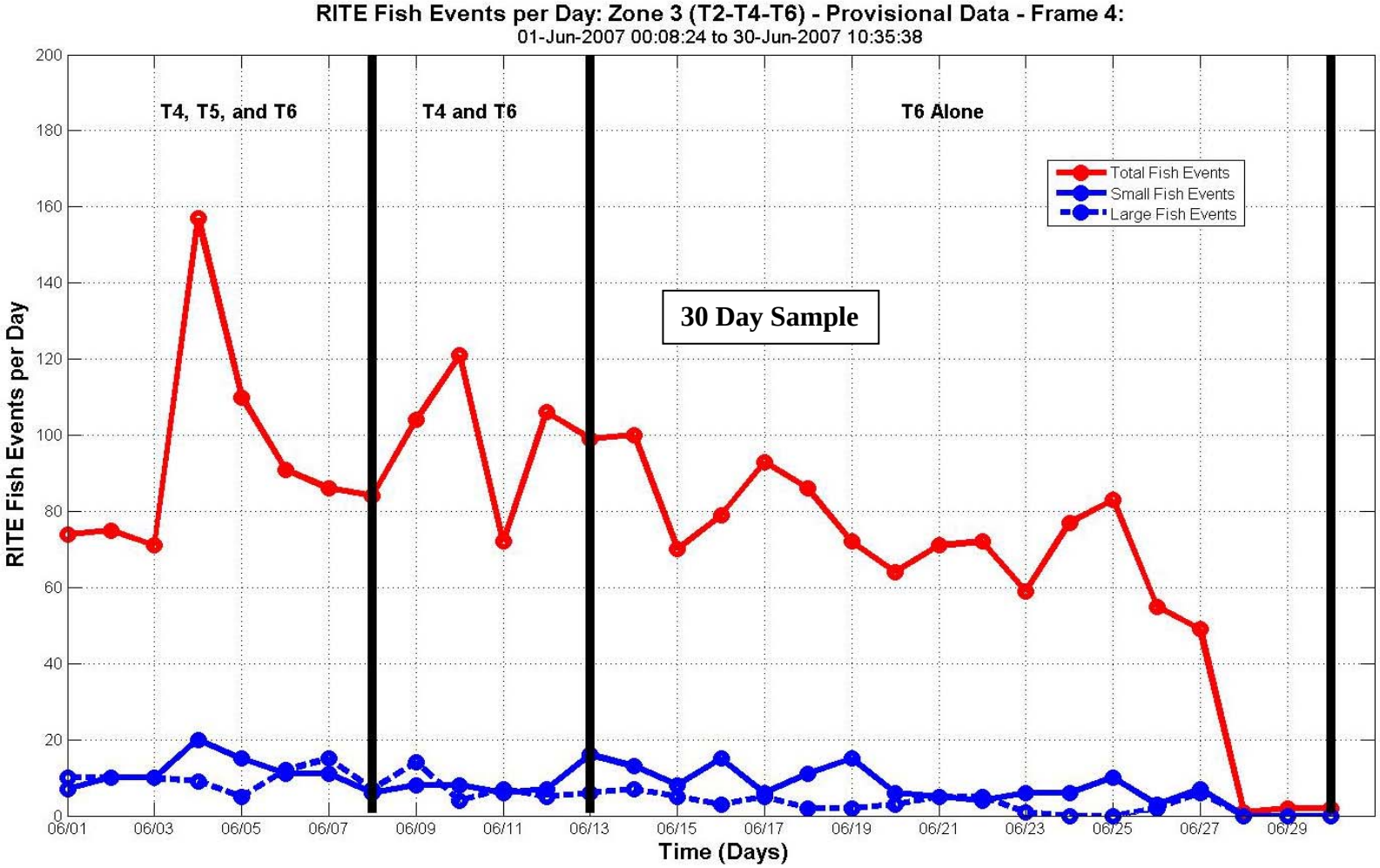
Figures A.17-I through A.17-III present details of the fish distribution observed during KHPS turbine operation in the two impact zones, as well as total fish events per day for Frame 4. A trend in target strength detection/observations is seen: more small fish near the inshore (T2-T4-T6) turbines, more large fish near the outshore (T1-T3-T5) turbines, very few fish (<30 per day) observed in the turbine impact zones.

Figure A.17-I RITE Project Comparison of Total and Impact Zone Fish Targets during Deployment 2: Zone 1 (T2-T4-T6) and Zone 2 (T1-T3-T5) – June 2007 (Frame 4)



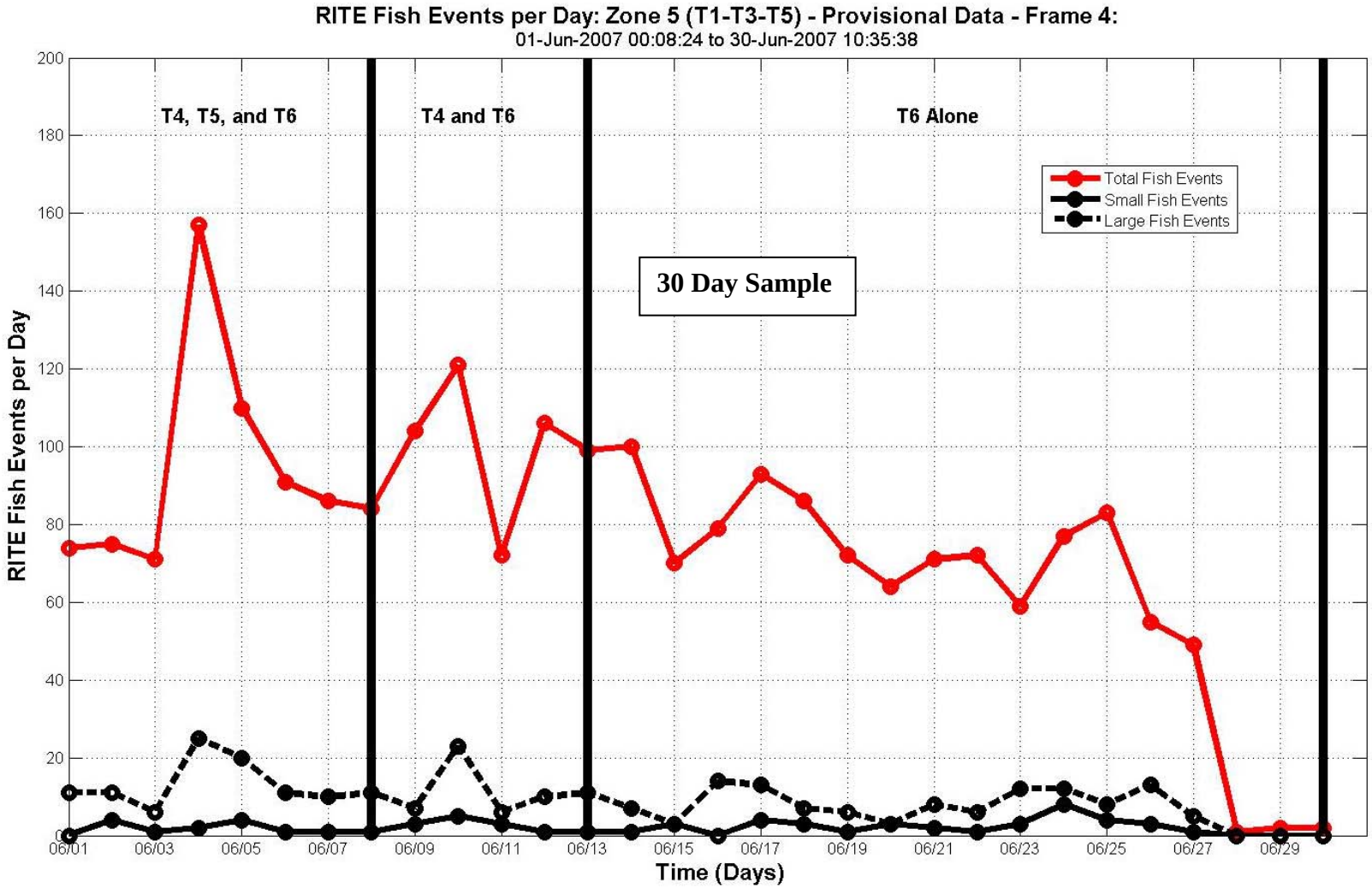
**** Presented in "FERC Draft License Application – Volume 2 – Exhibit E"***

Figure A.17-II RITE Project Small (Solid-Blue) and Large (Dashed-Blue) Fish Targets in Impact Zone 1 (T2-T4-T6) during Deployment 2 – June 2007 (Frame 4)



**** Presented in "FERC Draft License Application – Volume 2 – Exhibit E"***

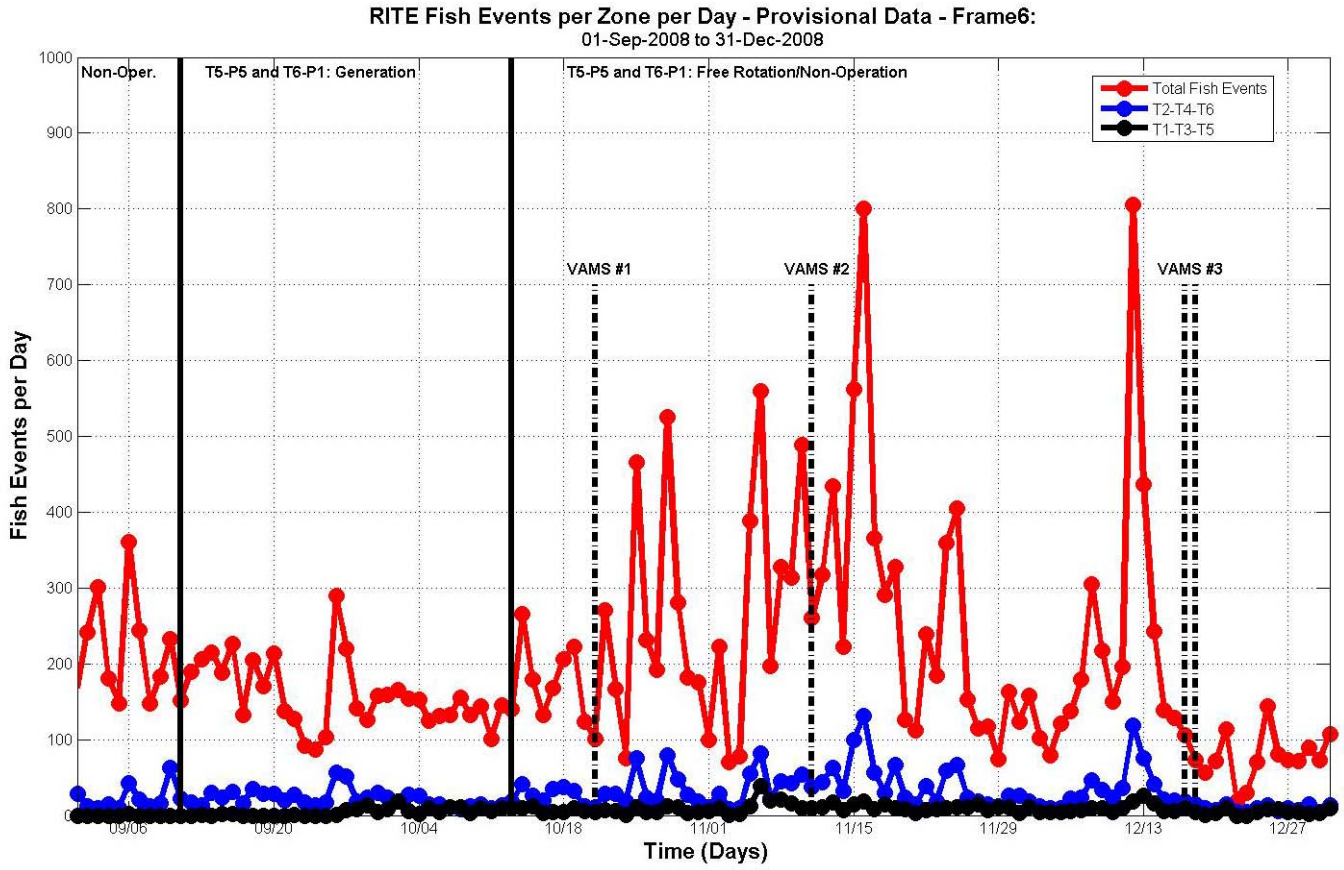
Figure A.17-III RITE Project Small (Solid-Black) and Large (Dashed-Black) Fish Targets in Impact Zone 2 (T1-T3-T5) during Deployment 2 – June 2007 (Frame 4)



**** Presented in "FERC Draft License Application – Volume 2 – Exhibit E"***

This plot confirms previous results from Deployment 2 above, very few fish are observed in the turbine impact zones during turbine operation. Additionally, this plot highlights the value of stationary hydroacoustics to identify windows of increased fish abundance for scheduling DIDSON monitoring, mobile in this case, as seen in fish abundance around VAMS #2.

Figure A.18 RITE Project Total and Impact Zone Fish Targets during Deployment 3 and Afterwards with Mobile Hydroacoustic (VAMS) Dates: Zone 1 (T2-T4-T6) and Zone 2 (T1-T3-T5) September – July 2007 (Frame 6)



**** Presented in "Final Fixed Hydroacoustics and Groundtruthing Report for Deployment #3" PowerPoint Presentation via webinar 3/6/09***

At the suggestion of NYSDEC in lieu of the 3 tidal period, day/night, large fish/small, 12 sector pie charts presented previously, the same data for Frame 3 was reprocessed in the tabular form shown below and also in pie chart form in Figures A.20-I through A.20-III. Please refer to Figure A.1 and Figure A.2 for schematics.

These figures represent:

- Two "operational" periods
    - Operation = Rotating
    - Non-Operation = Non-Rotating
- Three zones:
    - Non-Impact Zones
    - Impact Zone 1 – Inshore Turbines (T2-T4-T6)
    - Impact Zone 2 – Outshore Turbines (T1-T3-T5)
- Differentiation between large fish and small fish.

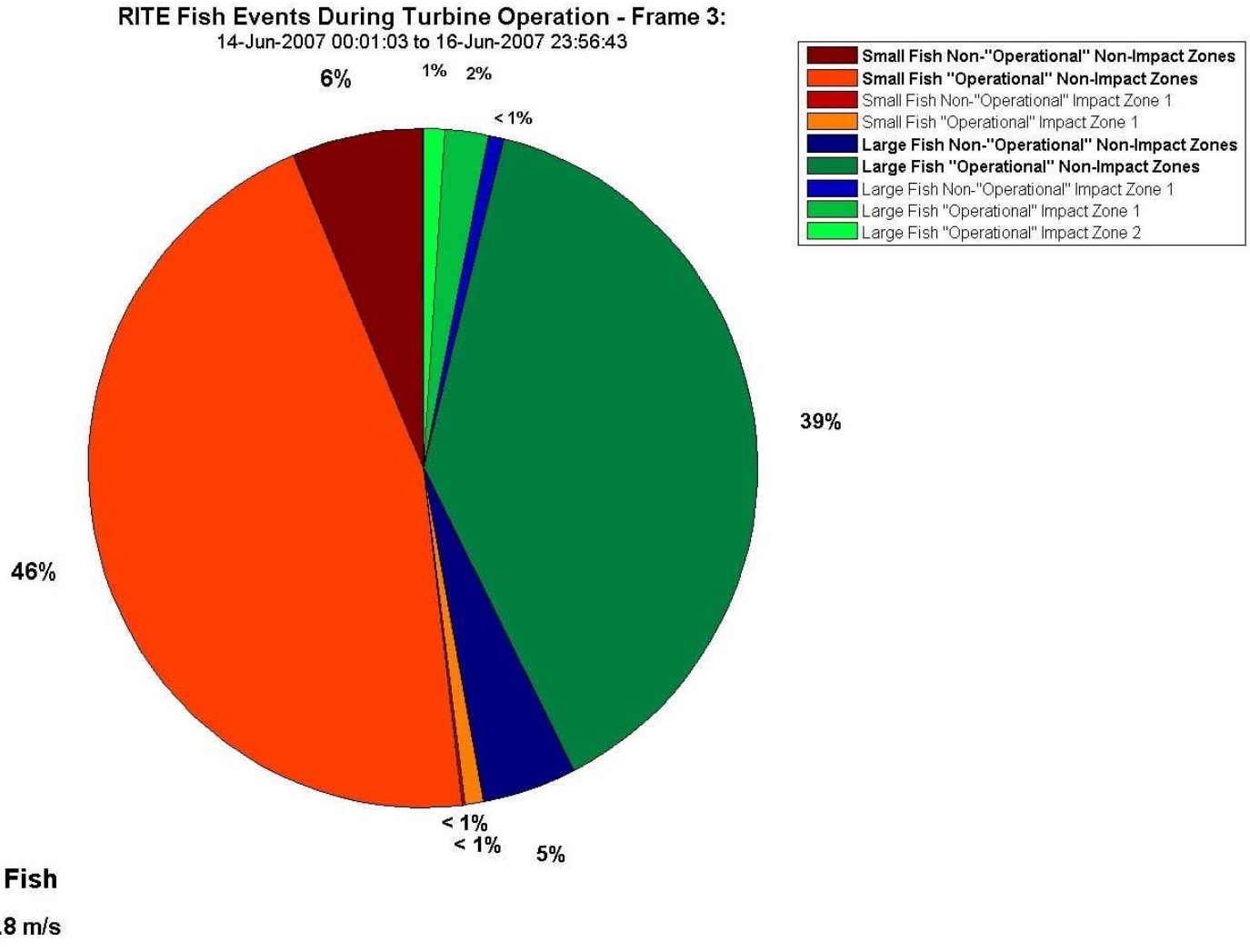
Since the KHPS operates when water velocity is > 0.8 m/s, roughly 18 hours per day, and is non-operational the remaining 6 hours per day, this representation is more useful ***in understanding fish movement; which is strongly weighted towards zones where KHPS are not located; or likely to be located in a full field build-out.*** Three, 3-day periods are shown − June, December, and March 2008 − for Frame 3. Yellow shading below indicates the turbine impact zones and the low incidence of fish targets (events) observed.

Figure A.19 RITE Project Fish Abundance during KHPS Operational and Non-Operation – 3 Days for 3 Months (Frame 3)

KHPS Operational Pie Charts	Operation Non Impact Zones	Operation Impact Zone 2 T1-T3-T5 (Outshore)	Operation Impact Zone 1 T2-T4-T6 (Inshore)	Non-Operation Non-Impact Zones	Non-Operation Impact Zone 2 T1-T3-T5 (Outshore)	Non-Operation Impact Zone 1 T2-T4-T6 (Inshore)	Total Fish 3 days
Jun14-16							569
Large Fish	39%	1%	2%	5%	0%	<1%	
Small Fish	46%	0%	<1%	6%	0%	<1%	
Dec 3-5							3114
Large Fish	33%	<1%	10%	3%	<1%	1%	
Small Fish	41%	<1%	6%	4%	<1%	<1%	
Mar7-9							356
Large Fish	29%	<1%	7%	3%	<1%	<1%	
Small Fish	42%	<1%	7%	9%	0%	<1%	

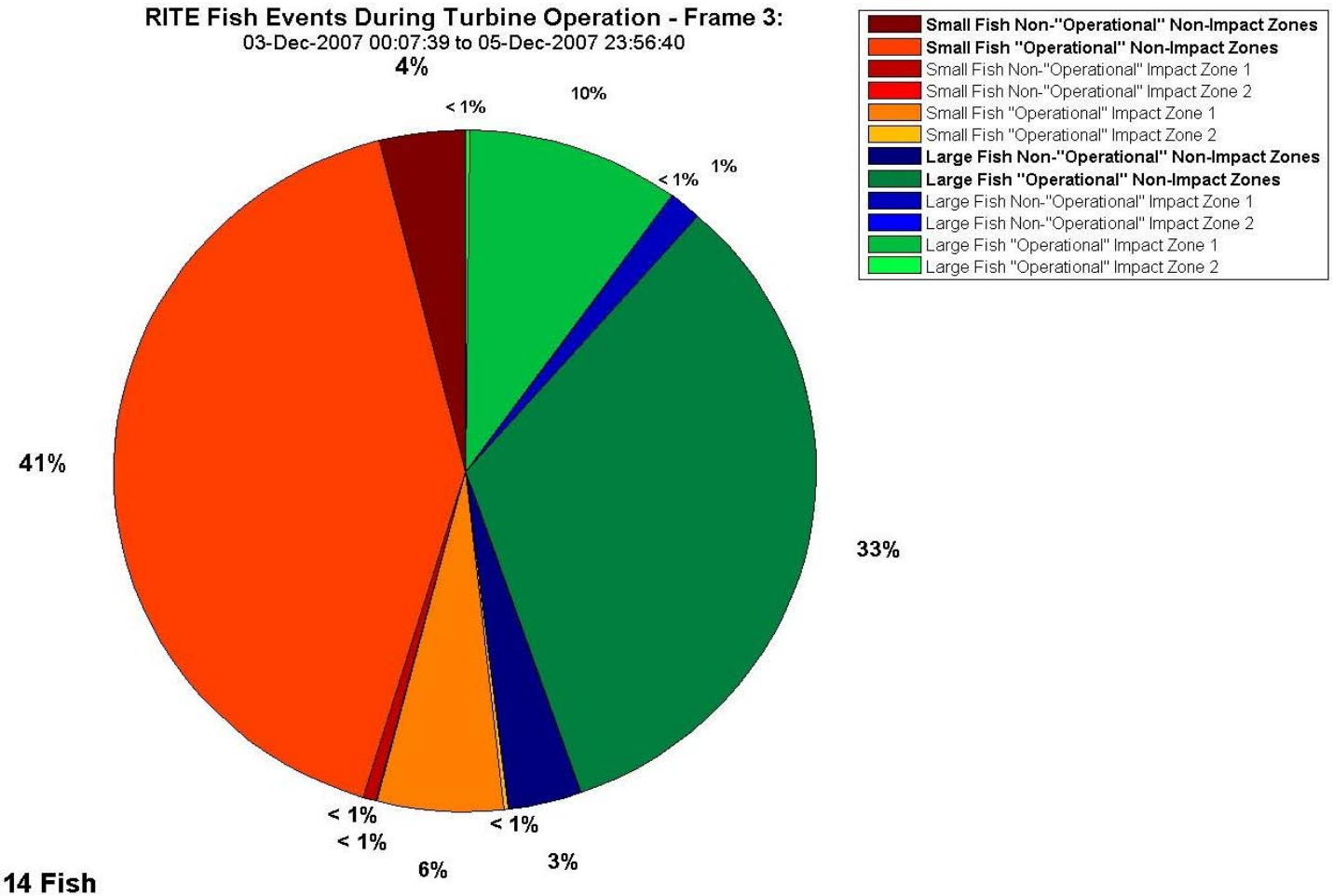
**** Presented in "FERC Draft License Application – Volume 2 – Exhibit E"***

Figure A.20-I RITE Project Sized, Zonal, Operational Fish Distribution – June 14-16, 2007 (Frame 3)



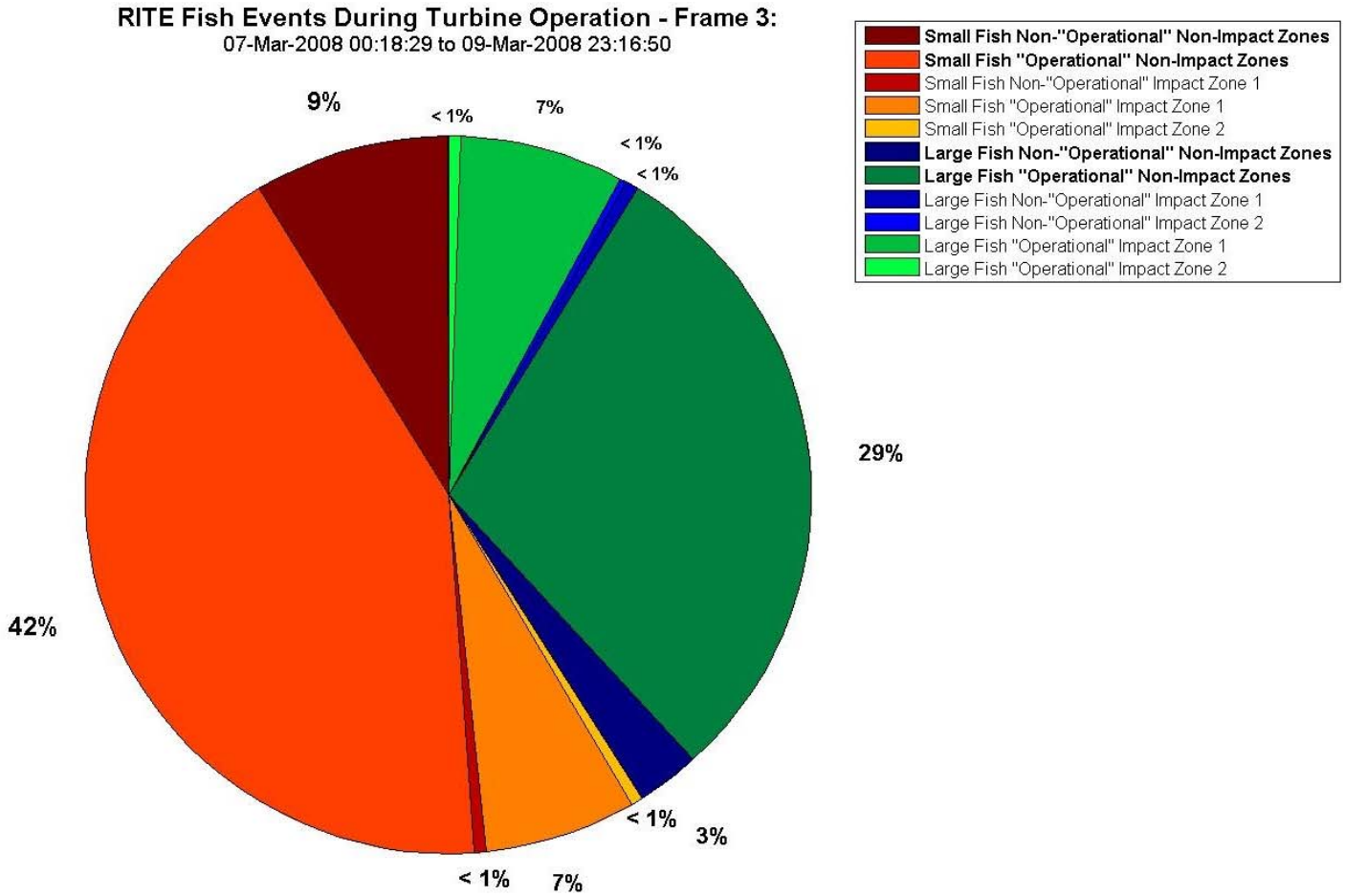
**** Presented in "FERC Draft License Application – Volume 2 – Exhibit E"***

Figure A.20-II RITE Project Sized, Zonal, Operational Fish Distribution –December 3-5, 2007 (Frame 3)



**** Presented in "FERC Draft License Application – Volume 2 – Exhibit E"***

Figure A.20-III RITE Project Sized, Zonal, Operational Fish Distribution – March 7-9, 2008 (Frame 3)



Total Fish Events = 356 Fish

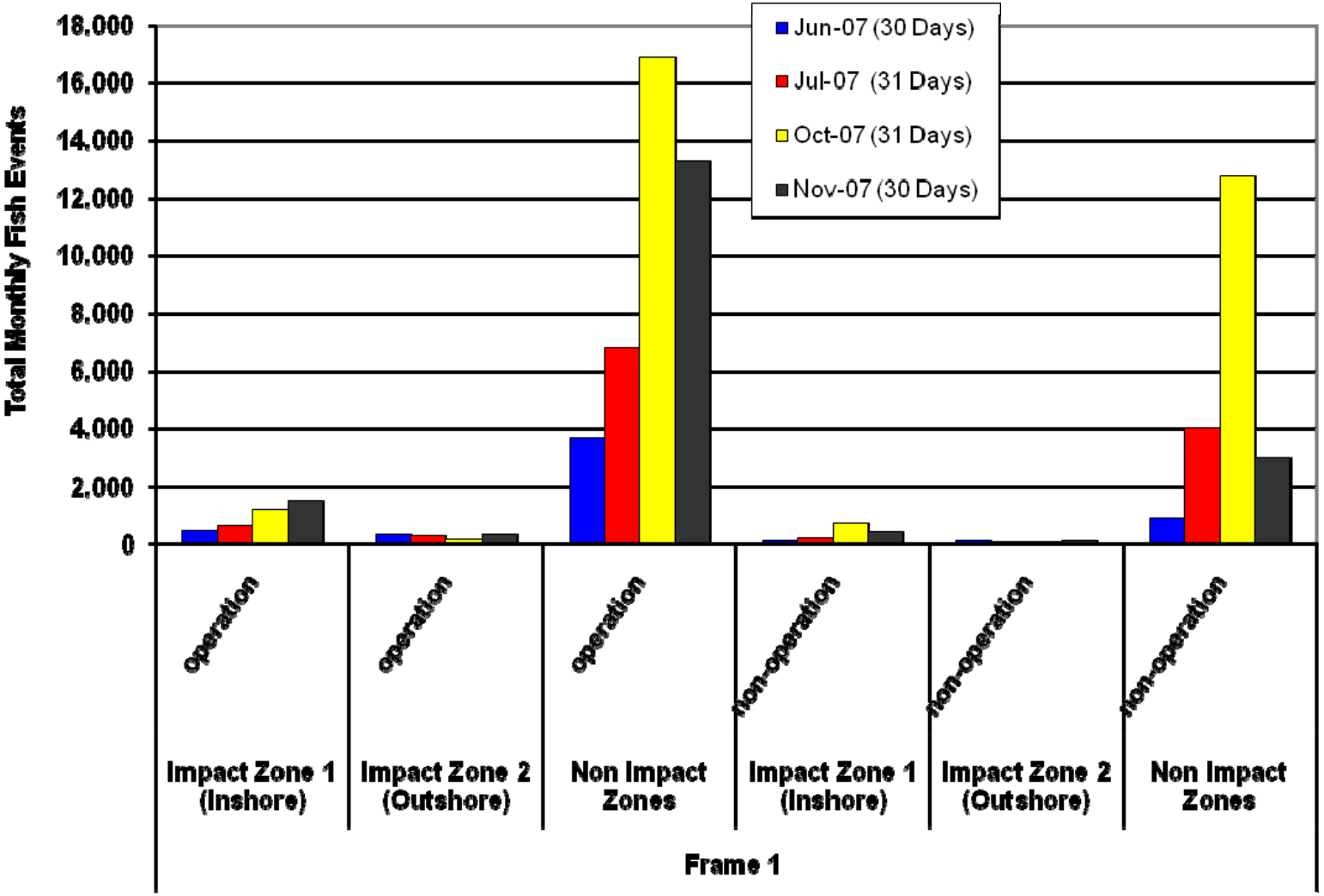
Turbine Operation: V_W > 0.8 m/s

**** Presented in "FERC Draft License Application – Volume 2 – Exhibit E"***

Figure A.21-I depicts the monthly distribution of fish targets observed in the turbine operating (impact) zones and non-impact zones for Frame 1 - selected because it has the most observations. Distributions for other frames over the same period show similar patterns. Even thought the KHPS turbines operate for 18 hours per day; the majority of the fish are clearly in the non-impact zones with or without turbine operation. ***This summary confirms previous observations that fish tend to the inshore and non- impact zones of the KPHS turbine array, likely minimizing opportunity for harm.***

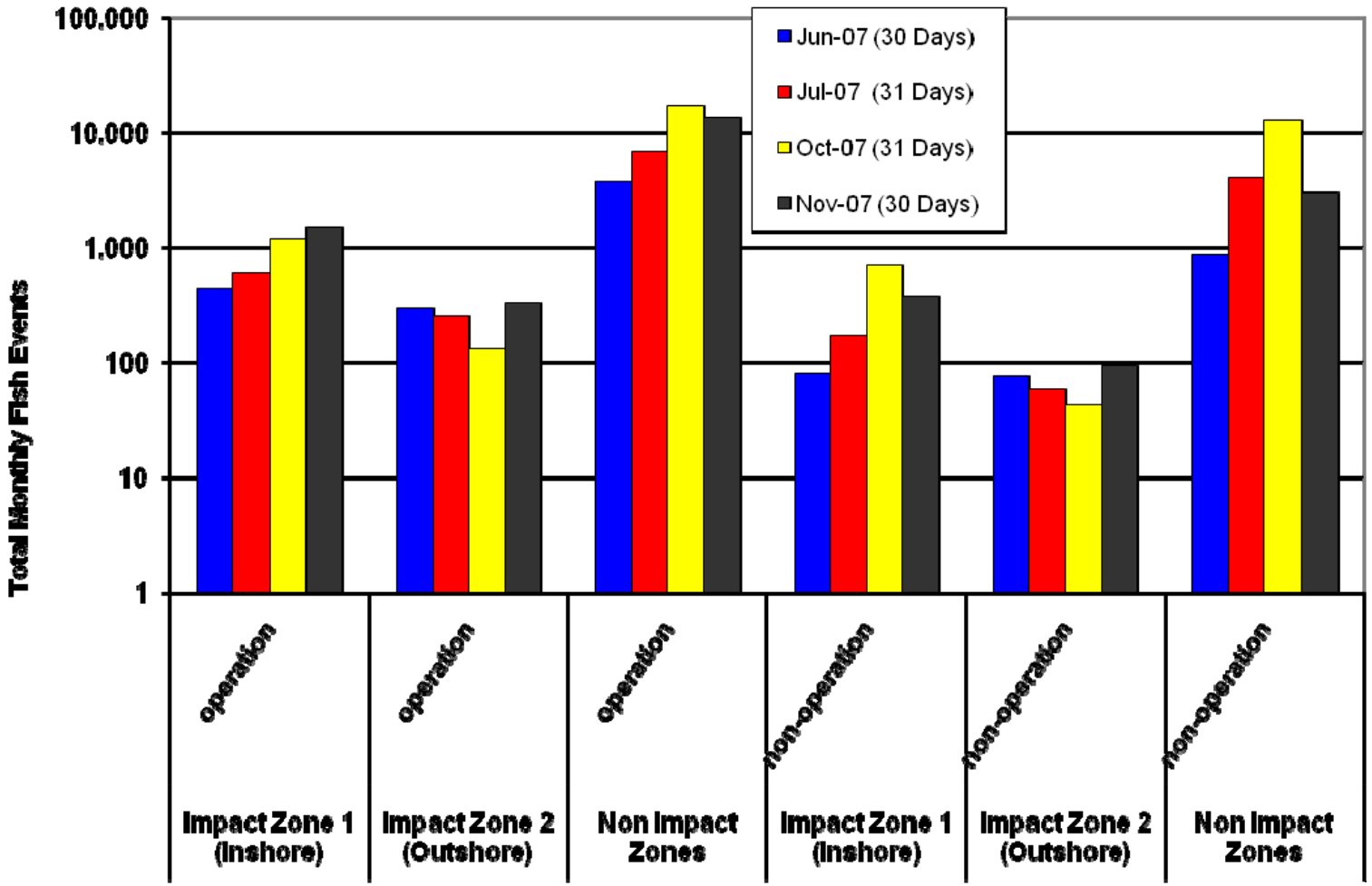
Figure A.21-II depicts the same monthly distribution of fish targets observed in the turbine operating (impact) zones and non-impact zones for Frame 1 as Figure A.21-I, however, the data is shown on a logarithmic scale as requested by the agencies, to more clearly see the interaction at lower observation density levels. The reader is cautioned that visually this depiction can be misleading since the y-axis scale is an order of magnitude different and therefore is not comparative at observational scale.

Figure A.21-I RITE Project Summary of Fish Targets in Turbine and Non-Impact Zones with Operational vs. Non-Operational Periods – 4 months (4 Frames)



**** Presented in "FERC Draft License Application – Volume 2 – Exhibit E"***

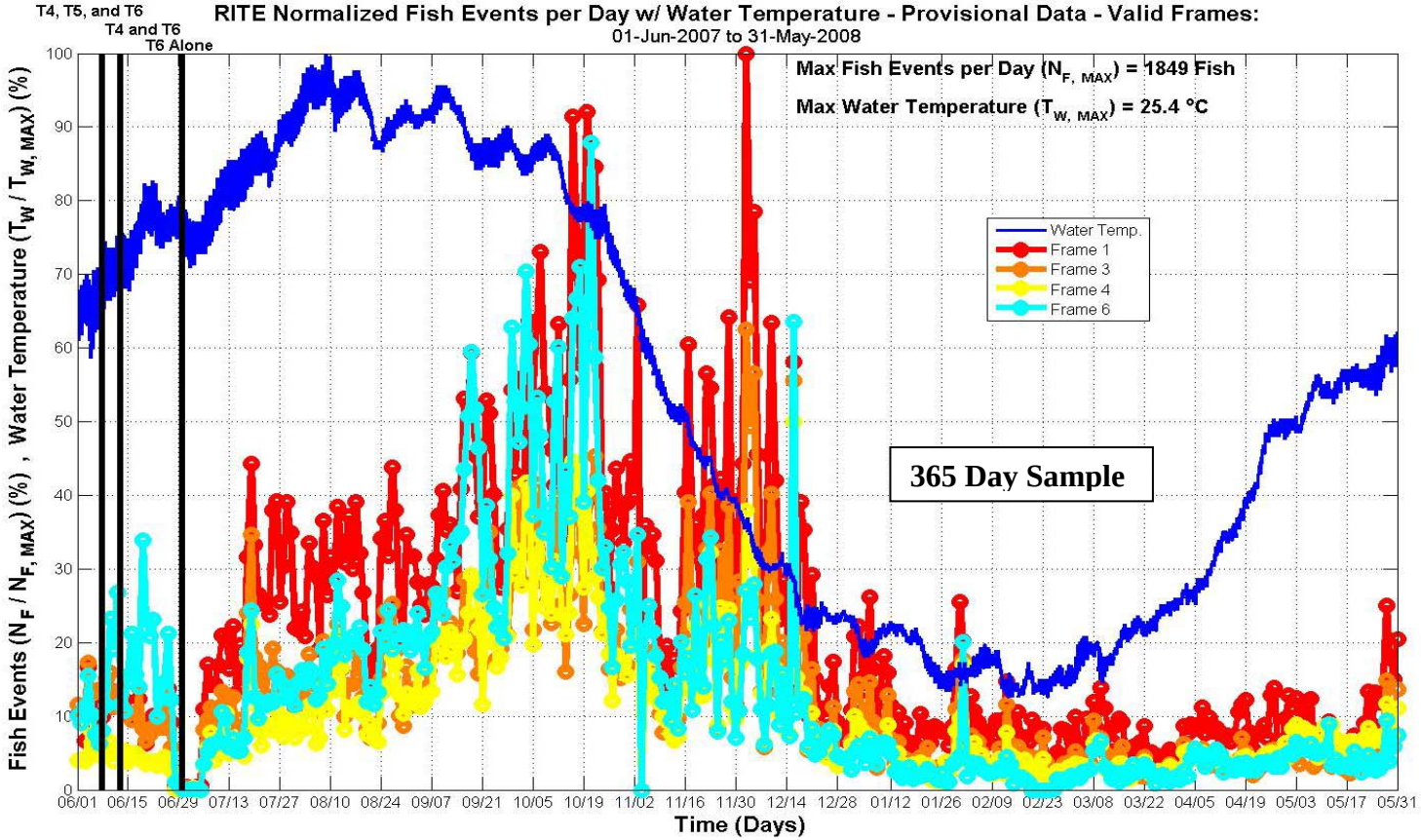
FigureA.21-II RITE Project Summary of Fish Targets in Turbine and Non-Impact Zones with Operational vs. Non-Operational Periods: Logarithmic Scaling – 4 Month (4 Frames)



**** Presented in "FERC Draft License Application – Volume 2 – Exhibit E"***

This plot shows an overlay of temperature data (taken at the reference ADCP location, between T1 and T3) through May 2008. The water temperature has been normalized by the peak value, 25.4°C, seen on the 10th of August 2007. The East River water temperature can be seen to range from roughly 4°C to over 25°C in the course of 1 year.

Figure A.22 RITE Project Water Temperature with Fish Abundance Overlay June 2007 to May 2008 (4 Frames)



**** Presented in "FERC Draft License Application – Volume 2 – Exhibit E"***

Table 1 RITE Project Proposed Monitoring Dates, 2011

SBT MONITORING	DATES	DURATION	RATIONALE
	9/15/11 – 12/15/11	**90 Days**	**Known Fall Migration**
DIDSON			
	11/15/22 – 12/15/11	**3 Weeks**	**Low Tide Height Difference, Known Presence of Large Fish**
Netting			
N1	**9/19/11**	**1 Day**	**Lowest Tide Height Difference (Preferred Date)**
N2	**10/5/11**	**1 Day**	**Half Moon**
N3	**10/19/11**	**1 Day**	**Low Tide Height Difference (Preferred Date)**
N4	**11/3/11**	**1 Day**	**Half Moon**
N5	**11/18/11**	**1 Day**	**Half Moon**
N6	**12/3/11**	**1 Day**	**Low Tide Height Difference (Preferred Date)**