WESTERN GRAY WHALE ADVISORY PANEL **WGWAP 2/INF.11**

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Western Gray Whale Weekly Average Estimated Densities (2001-2006) and Modelled Acoustic Footprints During the 2005 - 2006 SEIC Construction Season

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Sakhalin Energy Investment Company LTD.

Western Gray Whale Weekly Average Estimated Densities (2001-2006) and Modelled Acoustic Footprints during the 2005-2006 SEIC Construction Season

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CONFIDENTIAL

WESTERN GRAY WHALE WEEKLY AVERAGE ESTIMATED DENSITIES (2002-2006) AND MODELLED ACOUSTIC FOOTPRINTS DURING THE 2005 - 2006 SEIC CONSTRUCTION SEASON

1. BACKGROUND

This document has been developed in response to recommendation WGWAP 1/006[1] in the recommendation table developed by the Western Gray Whale Advisory Panel (WGWAP) after the first official meeting in November 2006, Prangins, Switzerland. This recommendation was discussed further during a visit of a selected group of scientists from the WGWAP panel on 5-6 February 2007 in Vladivostok Russia, with a slightly more detailed recommendation[2] issued to SEIC in a separate table in mid March (WGWAP/Vlad-02, WGWAP 1/006).

Assuming that the recommendation was interpreted correctly, SEIC would develop maps that displayed the average WGW density distribution for every week for each of the 5 years that survey data were available (2002-2006), with each map overlain with the acoustic footprint for each phase of the 2005 and 2006 offshore construction activities. This would result in an approximately 300 maps. Because of the limited time available, and also in anticipation that a review of so many maps would not be very effective, SEIC decided to provide the panel with the information listed below in the hope that it will satisfy the objectives of the WGWAP scientists.

- Weekly average estimated densities of gray whales for each year of 2002 to 2006 in specific blocks of the feeding area at three spatial scales (entire area, 3 block scale with a north-middle-south division and a 15 block scale that divides the feeding area in both a north-south and an east-west direction). This resulted in 19 plots of density versus time that show variation in distribution between and within years on a weekly basis (see below

[1] The Panel **recommends** that it be provided with a full analysis using effort-corrected data on distribution, for each year that such data are available, overlaid onto the appropriate acoustic 'footprint' information. The results should be integrated to produce an appropriate multi-year comparison of distribution, particularly for years with and without significant anthropogenic noise.

[2] The Panel recommends that the integrated, effort-corrected data on western gray whale distribution for all years available and for all platforms (shore, vessel, aerial) be calculated on a weekly basis and provided as a document for the St. Petersburg WGWAP meeting. These distribution data should then also be overlain on the acoustic footprint for the corresponding periods.

for more explanation of this analysis).

- Maps with the predicted acoustic footprint for each phase of construction during the 2005 and 2006 construction seasons overlain with the block divisions of the feeding area (11 maps).

The maps with the acoustic footprints will show what part (block) of the feeding area is ensonified by the 120 dB sound level during a specific offshore activity at each spatial scale. The plot(s) for that block(s) will show the density of the whales during that activity.

The above information will enable a high level comparison between the distribution of whales within the feeding area and sound levels. However, note that research to date has shown that distribution of whales is mainly governed by the availability of food, and that benthos together with other environmental factors and sound levels need to be taken into account to understand the variation in distribution.

2. METHODS

Effort-corrected WGW distribution data are presented as WGW average estimated densities (WGW/km^2) for weekly time intervals throughout June to December for each year that systematic surveys suitable for the density analysis were conducted (2002 to 2006). WGW survey data from 2002 to 2005 aerial surveys, 2002 to 2006 vessel surveys, 2002 to 2006 shore-based behaviour scan surveys and 2004 to 2006 shore-based vehicle scan surveys were analyzed to produce estimates of WGW densities along the northeast Sakhalin Island coastline. Survey data were excluded during 26 September to 19 October 2004 when non-SEIC geophysical seismic surveys took place and had the potential to impact the "normal" WGW distribution.

The study area was divided into a grid of 1.0 x 1.0 km cells with a WGW density (WGW/km^2) estimated for each cell that was sampled during each survey. The density estimates incorporate each survey's effort (area of the grid cell that was surveyed) into the calculation of the WGW density estimate for that grid cell. Gray whale sightings were corrected for availability and perception bias that typically result in an underestimation of animal abundance (Marsh and Sinclair 1989) before performing the density calculations. An estimated density of zero was

assigned to a grid cell if no WGWs were sighted within that grid cell during a particular survey. The grid cell WGW density estimates for each survey were then used to calculate average WGW density estimates for each weekly time interval during each survey year. Average estimated WGW densities were assessed at the following three spatial scales because different distribution patterns are frequently evident at different scales (Wiens 1989):

a) The entire study area --approximately 968 km^2 (Map 1).
b) The region described in a) above subdivided into three blocks (north, central, south) – each approximately 323 km^2 -- to stratify the region latitudinally (Map 2).
c) The region described in a) above subdivided into 15 blocks, each approximately 64.5 km^2 (Map 3).

The weekly WGW average estimated densities for each survey year were then plotted for each block at each spatial scale (Figure 1 to Figure 5).

The acoustic footprint maps were generated from the numerical modelling of the sound levels from the operation, based on reasonably assumed distributions of vessels intended to provide representative – and generally conservative – snapshots of the operational scenarios in various phases of the construction work. For the 2005 acoustic maps, a post-season adjustment of the modelled forecasts was carried out to achieve best agreement with sound level measurements from underwater recorders, statistically averaged (90th percentile) over the duration of each operational phase. For the 2006 modelled acoustic footprints presented here this process of post-season adjustment was not performed because of the complexity and variability of the vessel distribution that undermines a static correlation of statistically averaged (90th percentile) measured levels over an entire operational phase with the corresponding modelled estimate. The footprints for 2006 are therefore as originally estimated, with the understanding that acoustic measurements taken throughout the season supported the assumption that the modelling did in fact provide a precautionary forecast.

The acoustic maps (Map 4 to Map 14) show the modelled acoustic footprints of SEIC's construction activities in 2005 and 2006, with the three spatial scales and associated blocks overlain. The block numbers are identified for each spatial scale. Combining the information of the acoustic footprint with the density of western gray whales for the different years within a certain block at a particular spatial scale should hopefully enable the WGWAP panel members to review the data and satisfy the objectives for their recommendation.

3. WGW DENSITY PLOTS AND ACOUSTIC FOOTPRINT MAPS

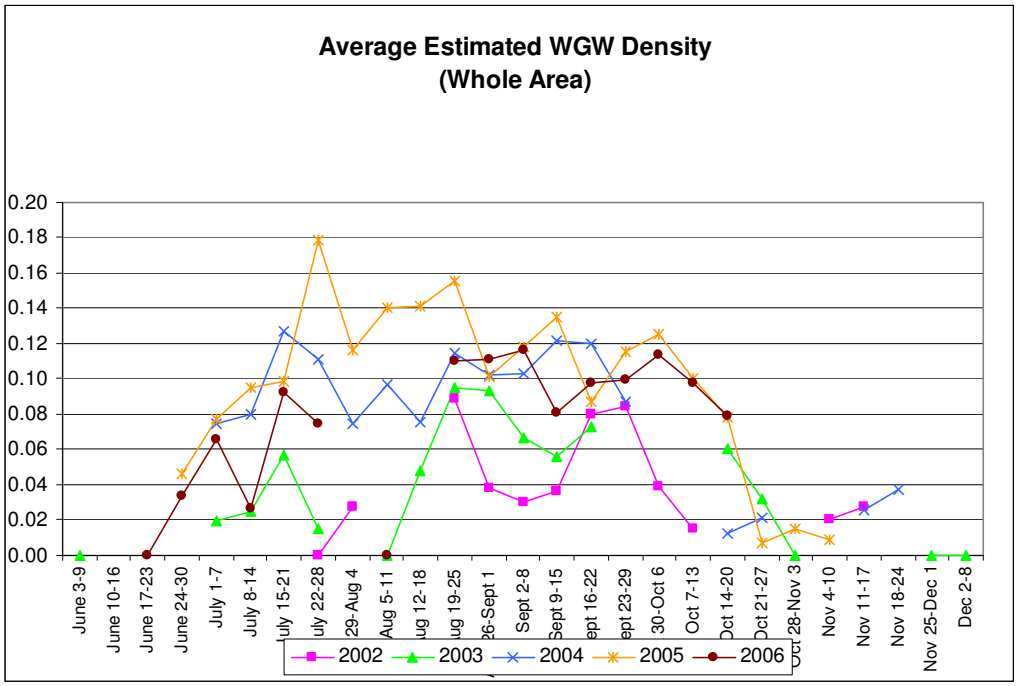


Figure 1. Average estimated WGW density for each week of the 2002-2006 surveys for the entire survey area.

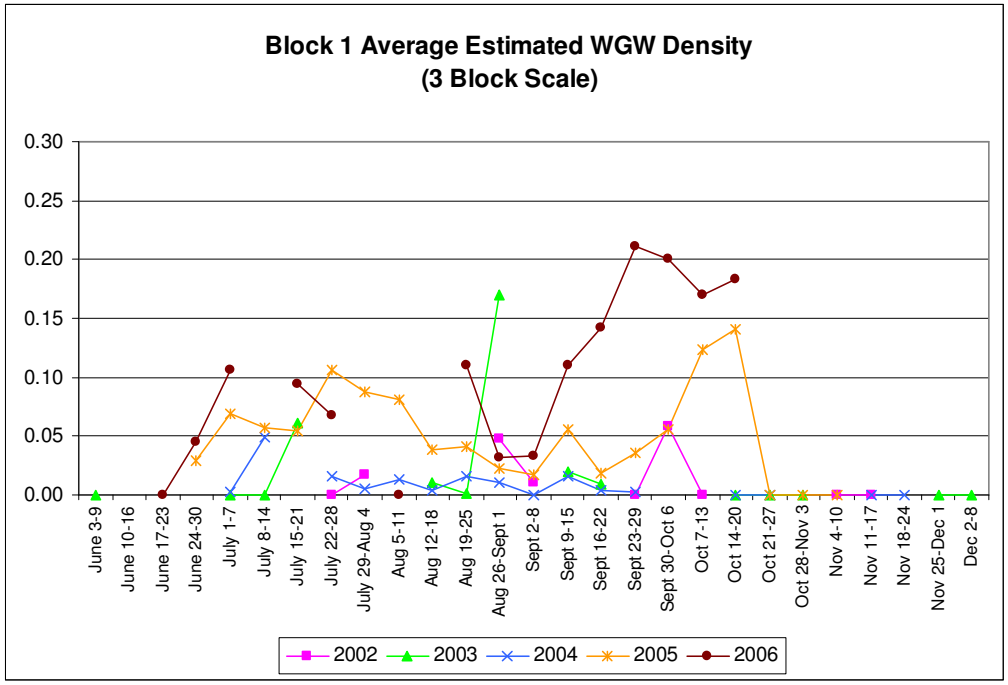


Figure 2. Average estimated WGW density for each week of the 2002-2006 surveys for the southernmost block (block 1) at the three block scale of analysis.

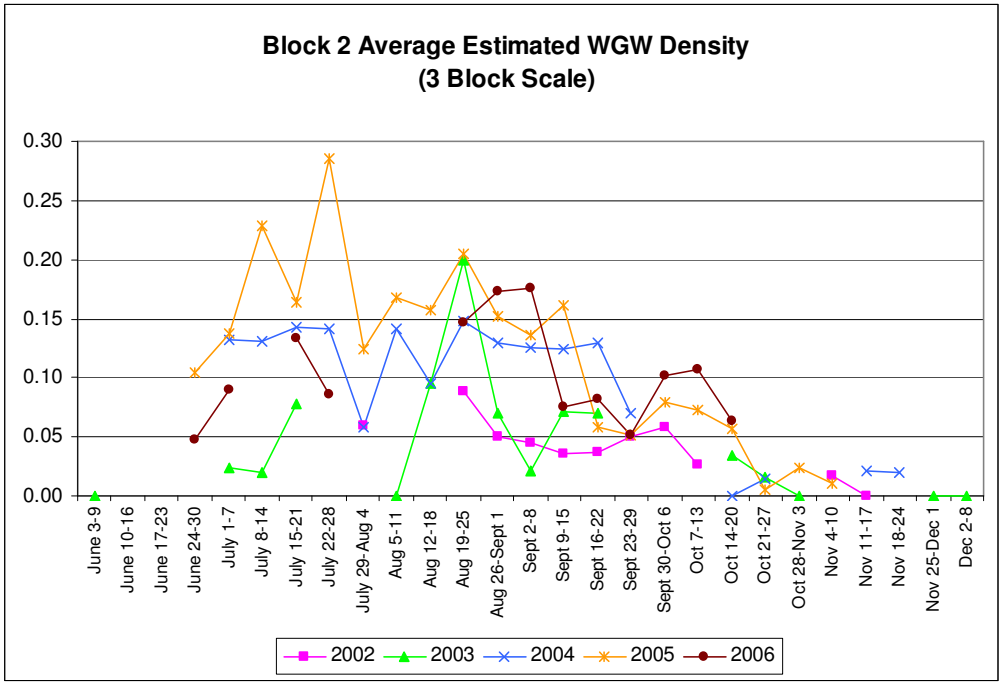


Figure 3. Average estimated WGW density for each week of the 2002-2006 surveys for the center block (block 2) at the three block scale of analysis.

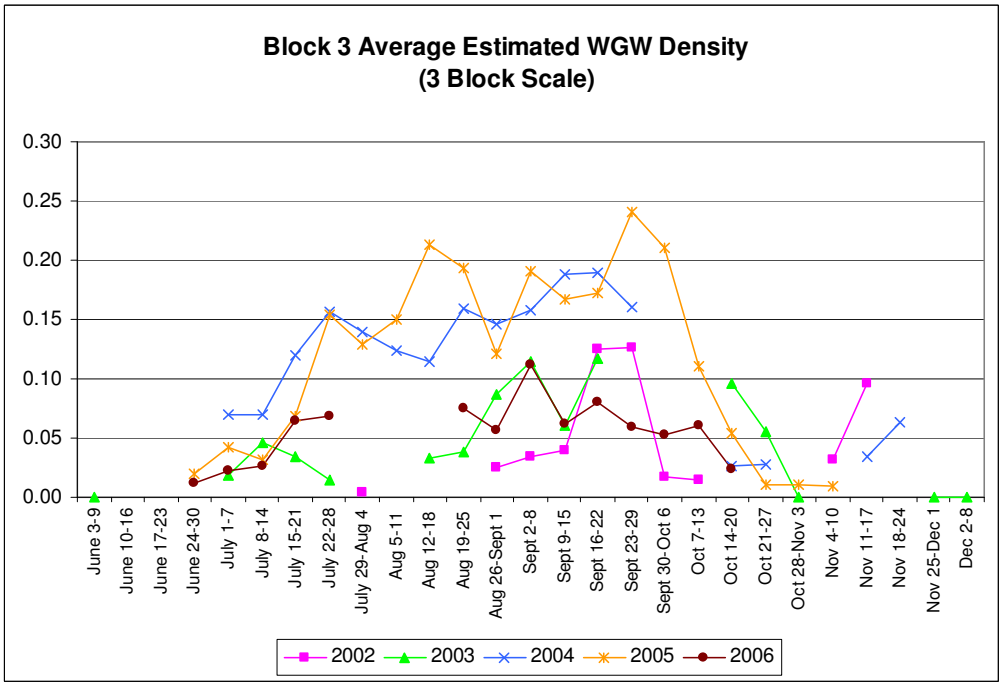
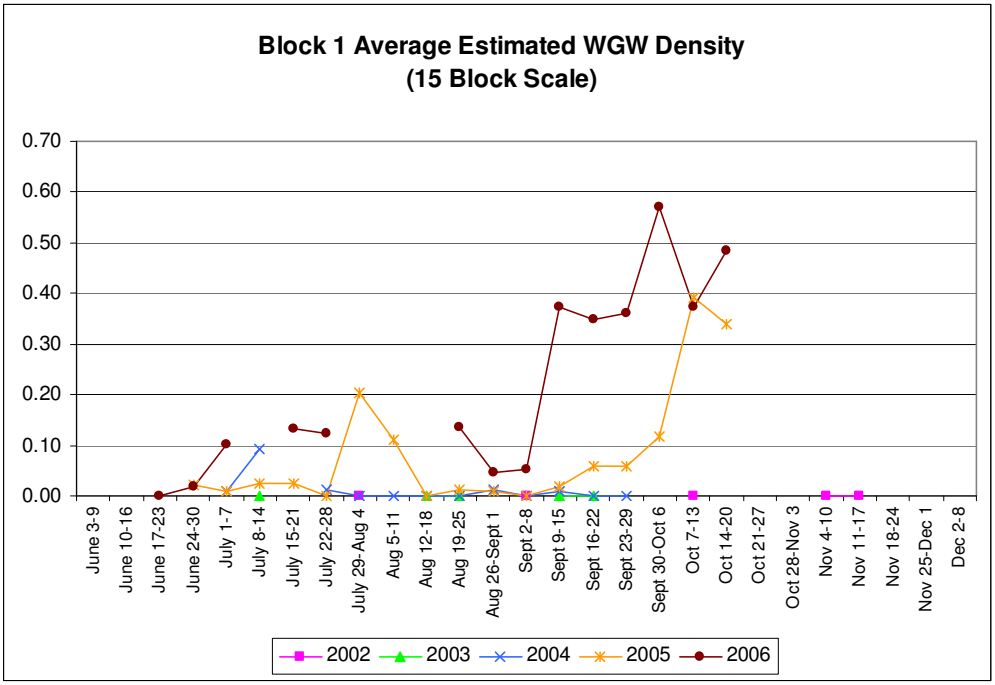


Figure 4. Average estimated WGW density for each week of the 2002-2006 surveys for the most

northern block (block 3) at the three block scale of analysis.



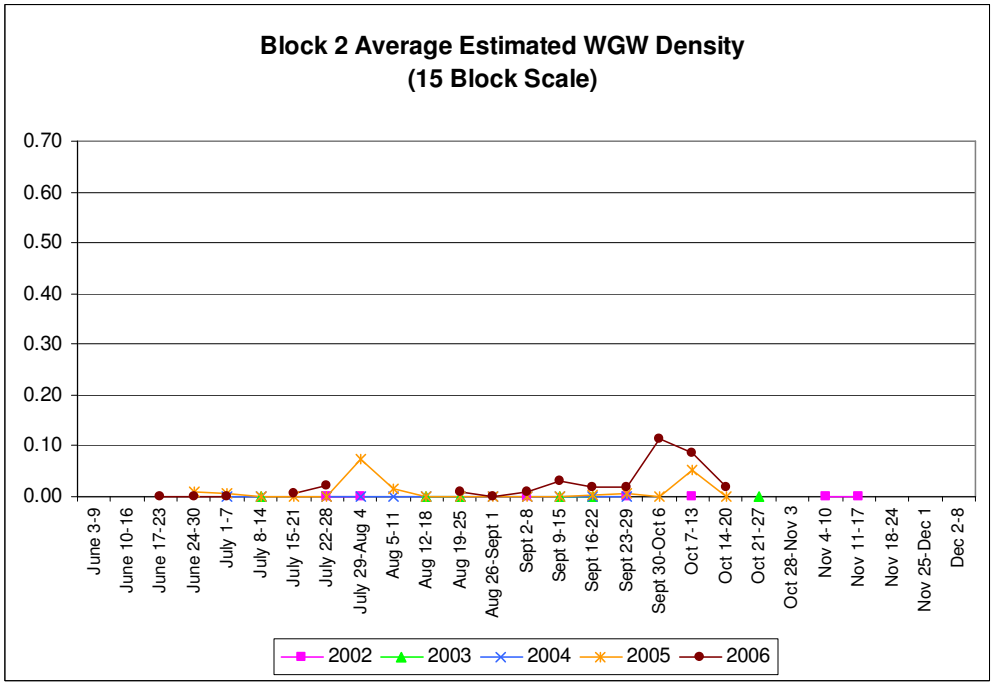
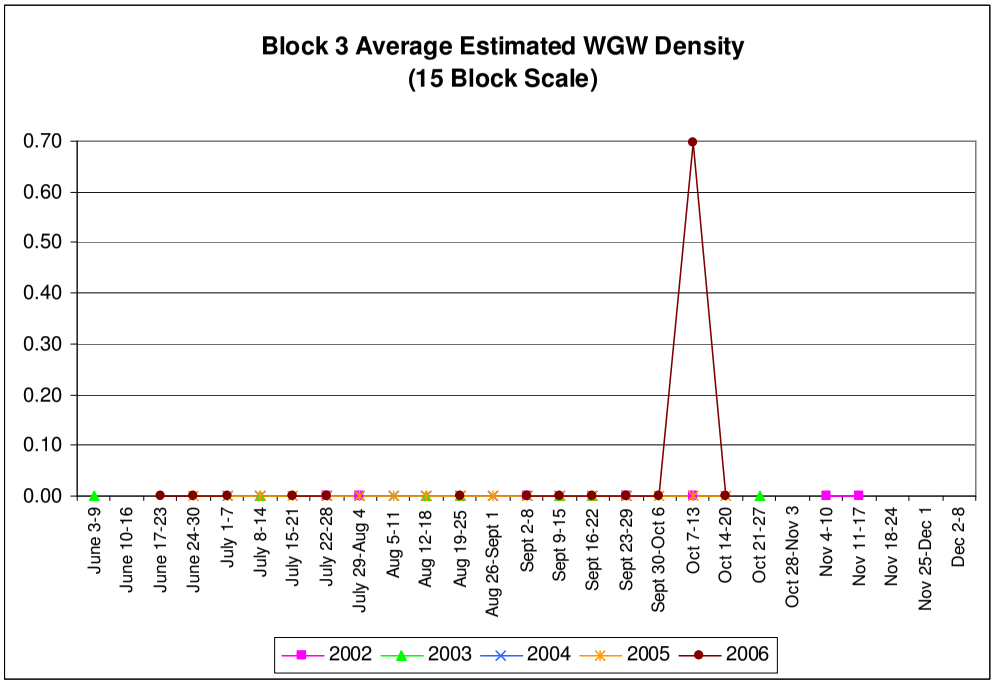


Figure 5. Average estimated WGW density for each week of the 2002-2006 surveys for blocks 1

to 15 at the fifteen block scale of analysis.



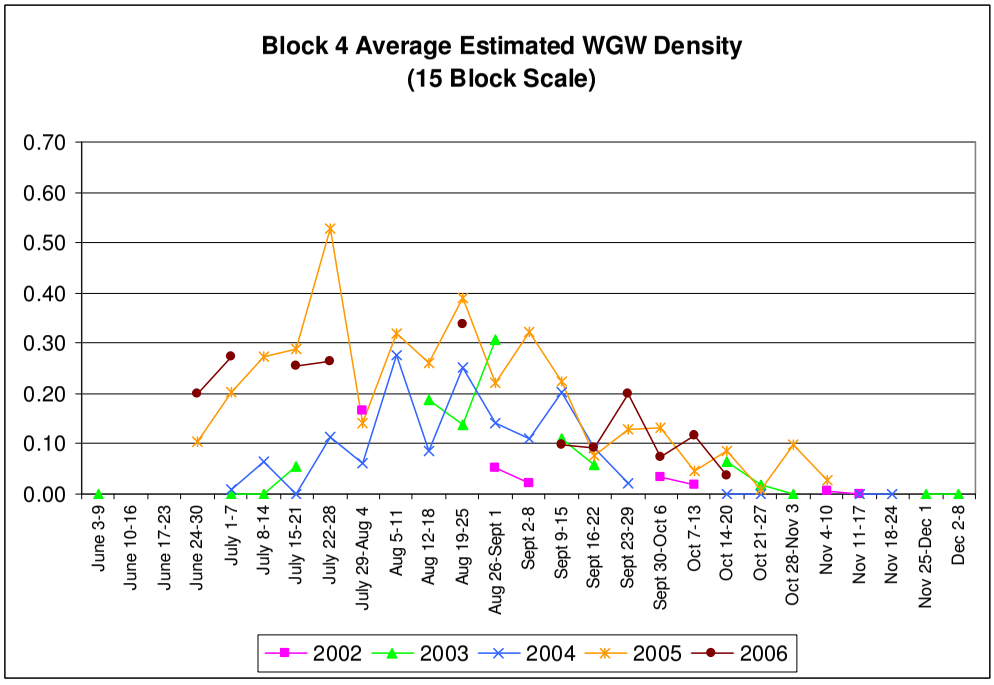
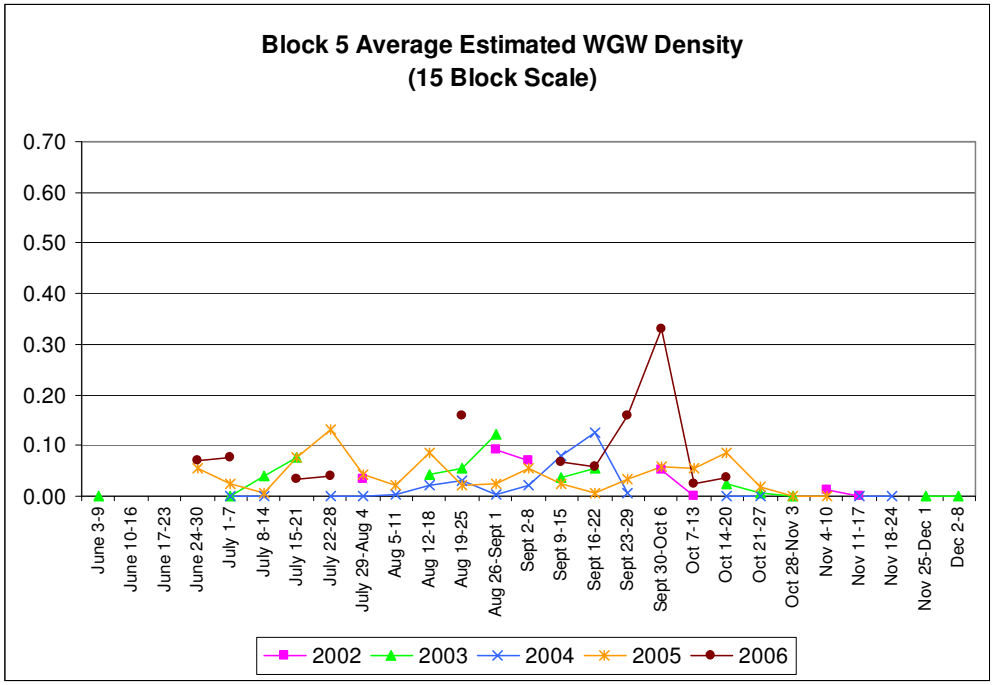


Figure 5 continued. Average estimated WGW density for each week of the 2002-2006 surveys for blocks 1 to 15 at the fifteen block scale of analysis.



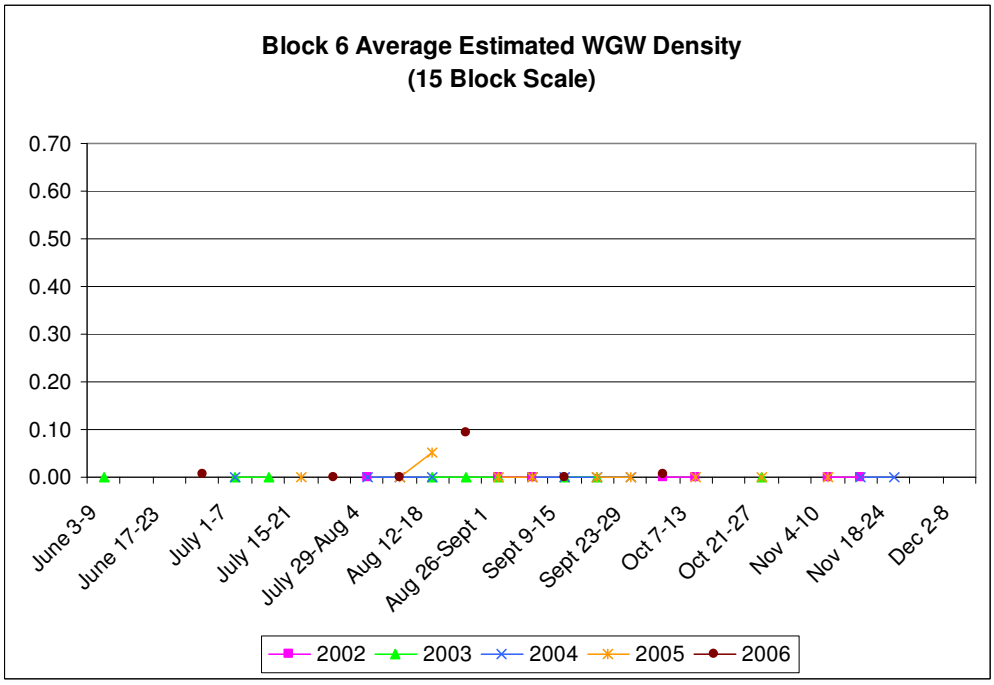
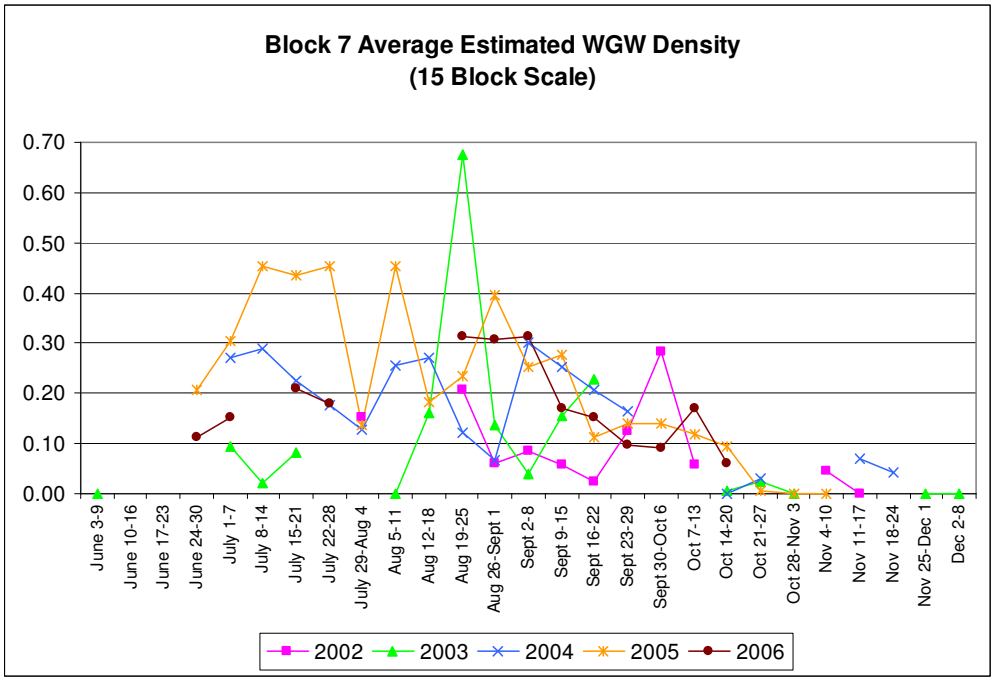


Figure 5 continued. Average estimated WGW density for each week of the 2002-2006 surveys

for blocks 1 to 15 at the fifteen block scale of analysis.



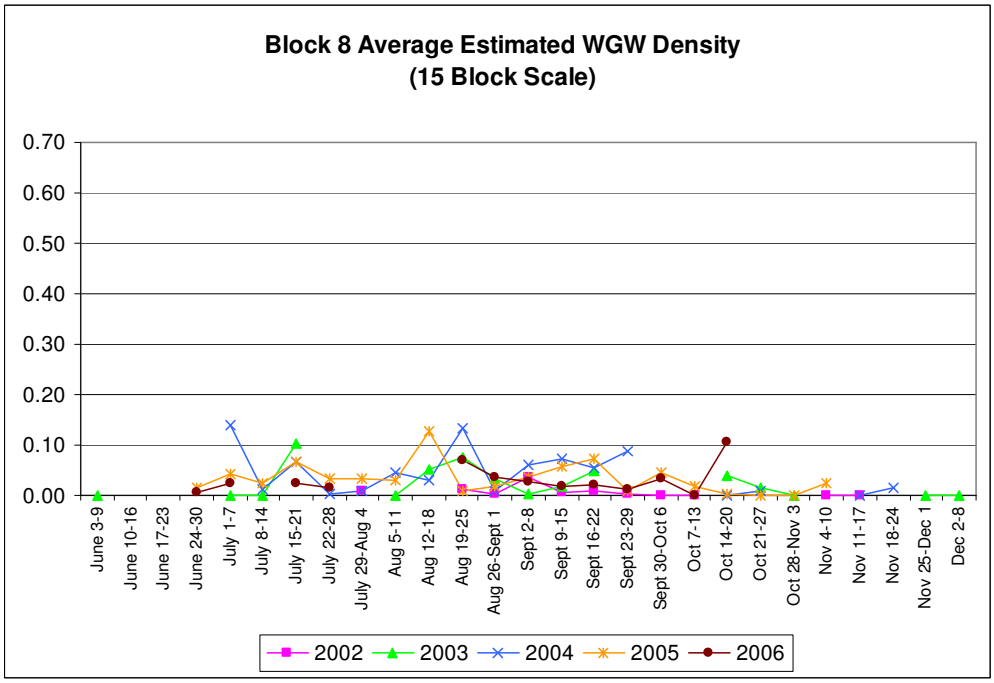
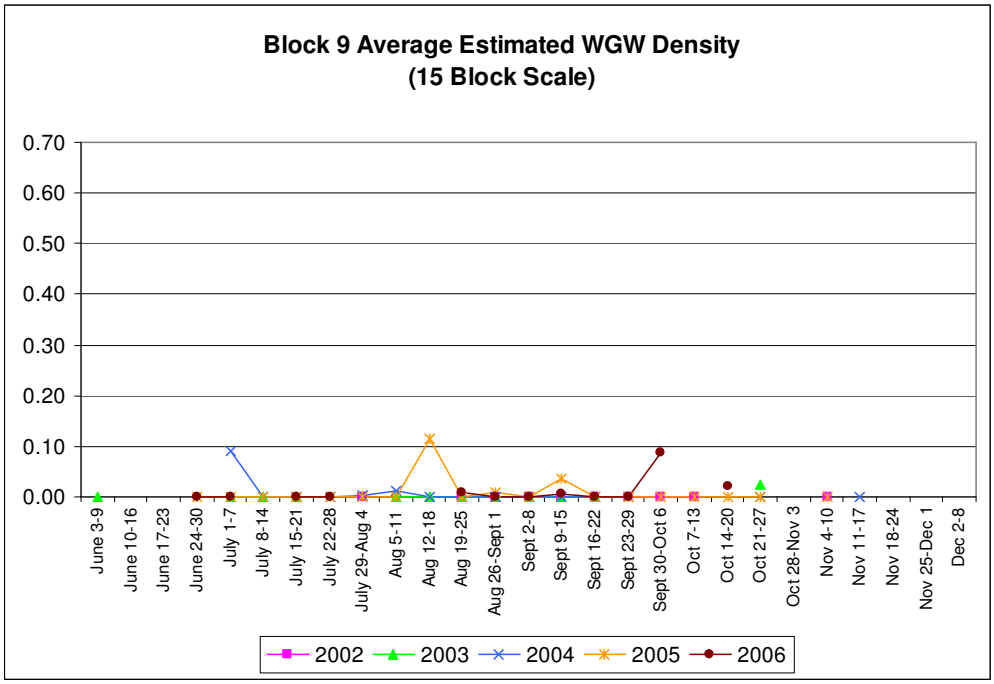


Figure 5 continued. Average estimated WGW density for each week of the 2002-2006 surveys

for blocks 1 to 15 at the fifteen block scale of analysis.



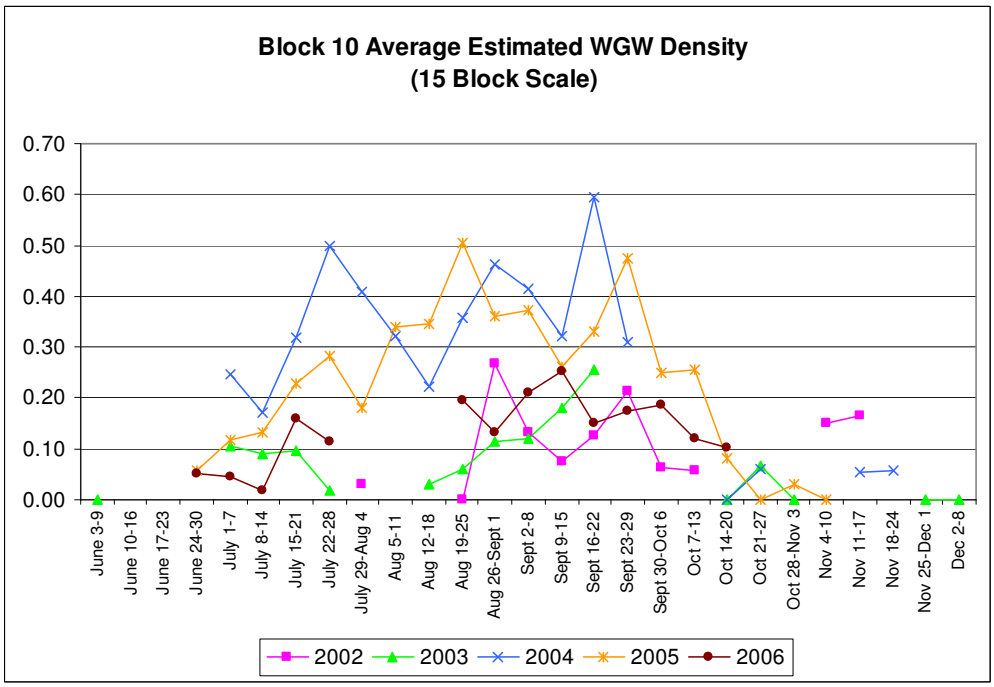
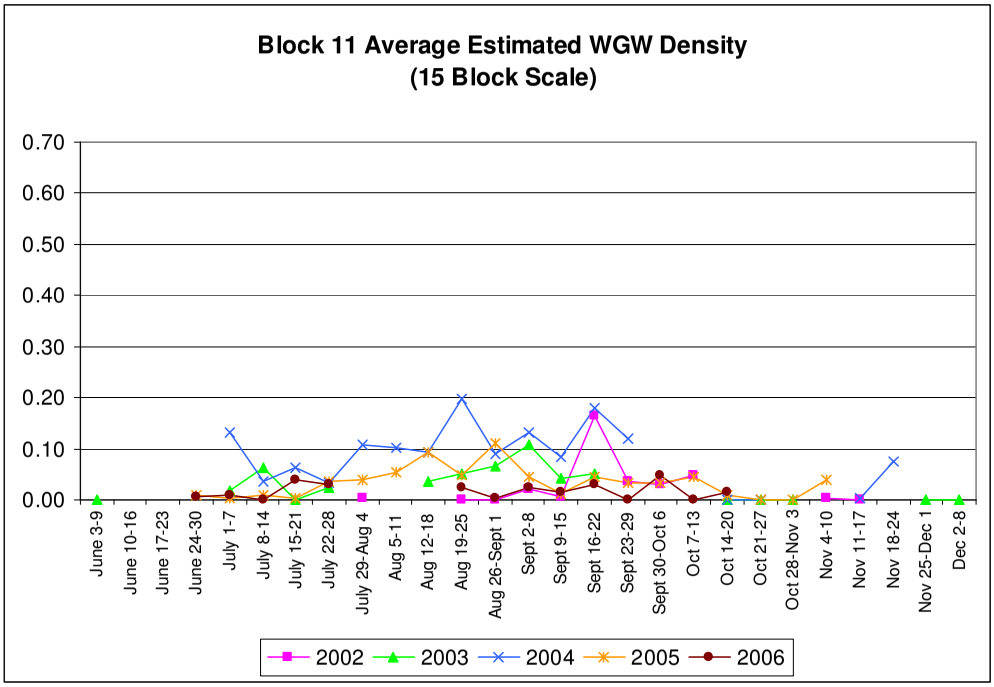


Figure 5 continued. Average estimated WGW density for each week of the 2002-2006 surveys

for blocks 1 to 15 at the fifteen block scale of analysis.



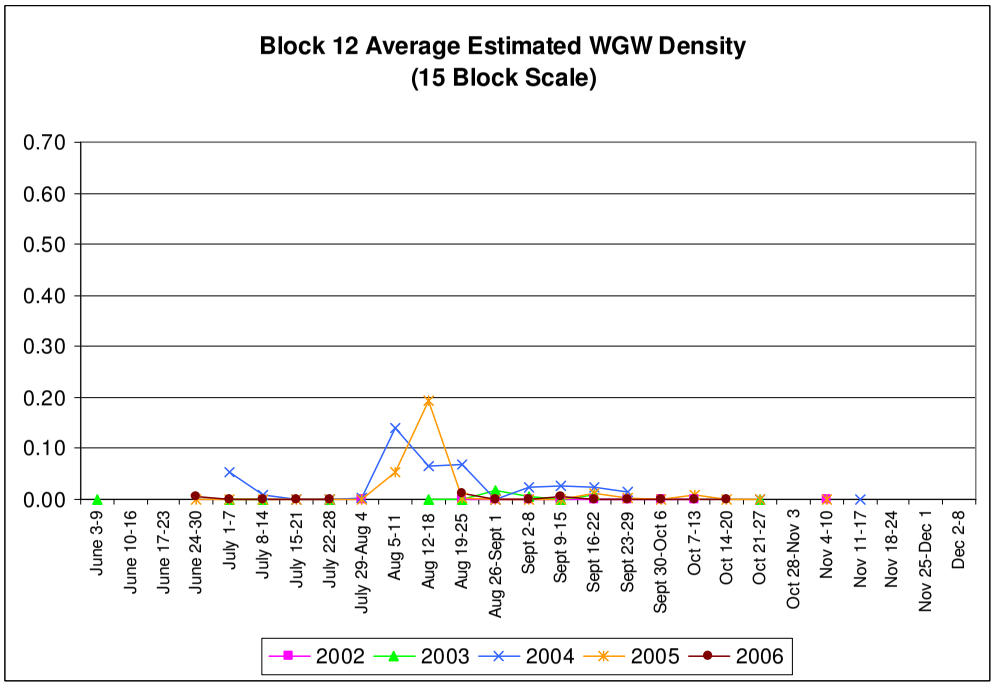
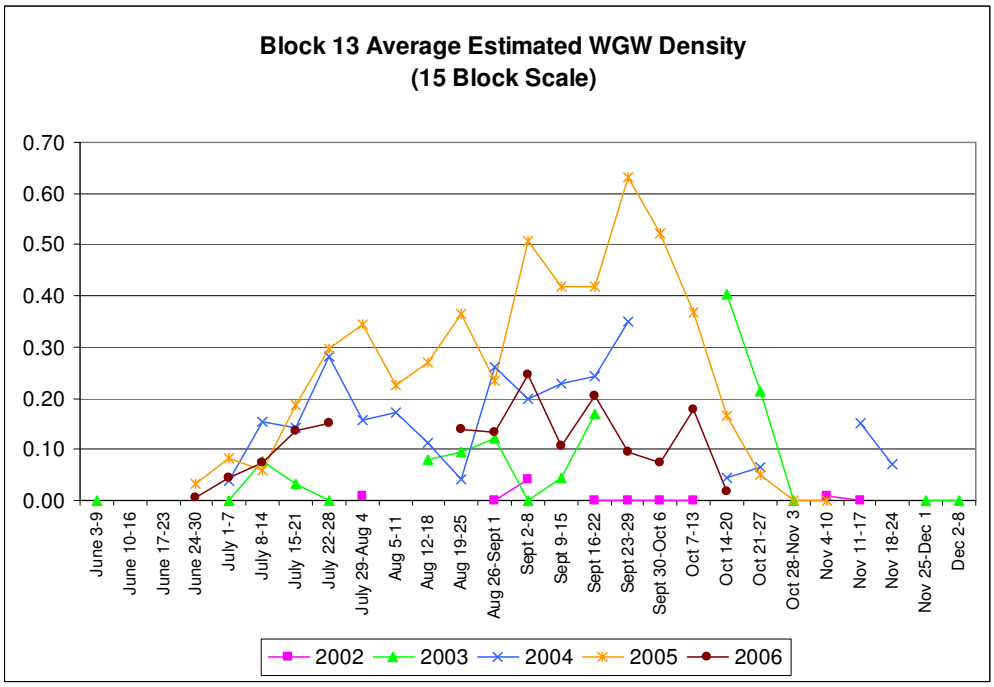


Figure 5 continued. Average estimated WGW density for each week of the 2002-2006 surveys for blocks 1 to 15 at the fifteen block scale of analysis.



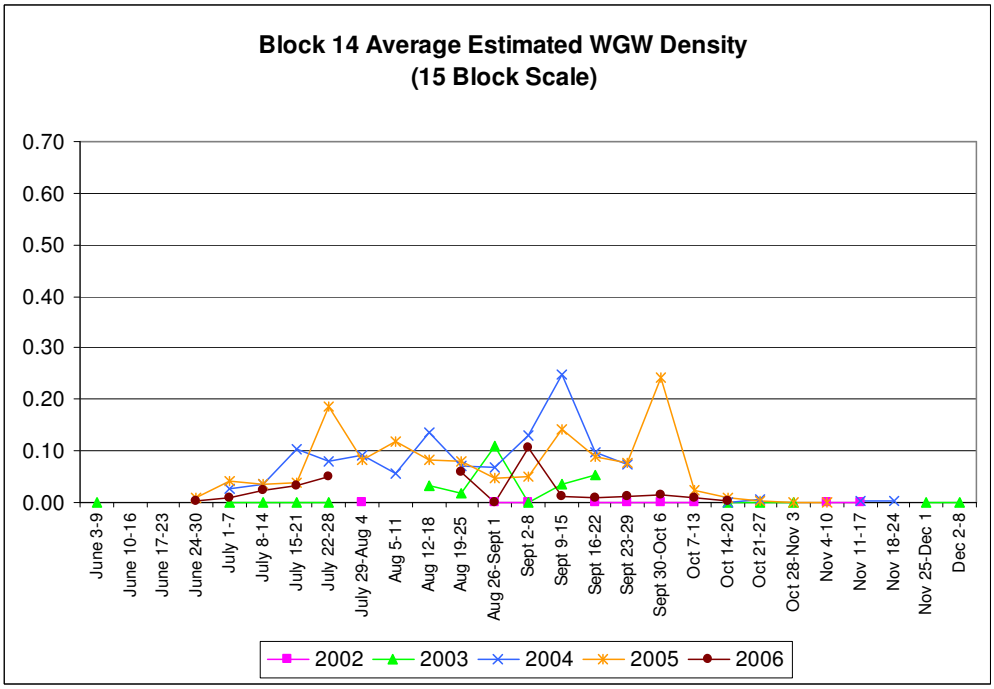


Figure 5 continued. Average estimated WGW density for each week of the 2002-2006 surveys

for blocks 1 to 15 at the fifteen block scale of analysis.

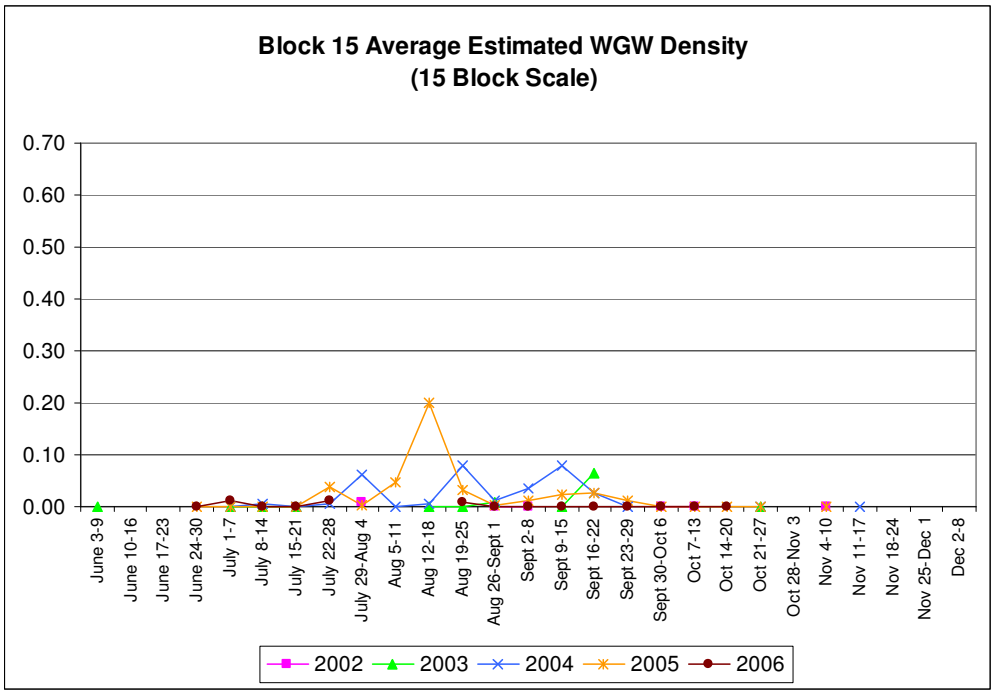


Figure 5 continued. Average estimated WGW density for each week of the 2002-2006 surveys for blocks 1 to 15 at the fifteen block scale of analysis.

4. LITERATURE CITED

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