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Border Security Analysis Between Ports of Entry

R. Greenwalt, W. Hibbard, B. Henderer

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Robert J. Greenwalt, Jr., Bruce D. Henderer, and Wilthea J. Hibbard
Lawrence Livermore National Laboratory
MS L-064, 7000 East Avenue, Livermore California 94550

ABSTRACT

We discuss the application of systems analysis tools and techniques to the development of counters to WMD smuggling across borders between legal ports of entry. This specific problem space is a mixture of threats, terrain, defensive technologies, and both smuggler and border enforcement tactics – all of which are subject to analysis. Various analytic techniques have been combined into a set applicable to border enforcement operations. This analysis leads to selection of specific Border Security solution sets which are then tested in a virtual test bed. We show an example illustrating employment of these techniques on a segment of the Iraq-Iran border.

INTRODUCTION

Smuggling across "frontier borders" between nations occurs worldwide and is quite different from smuggling through a legal port of entry (POE). At the POE, the issue is detecting contraband hidden on people or vehicles, many times amongst legitimate cargo. All border crossers pass through a screening or inspection station where customs agents attempt to discover the contraband without excessively hindering legitimate commerce. On the frontier border, however, all border crossers are illegal by definition and the border police problem is one of detection and interdiction.

Securing frontier borders against WMD material smuggling is a complex problem – reflected in the fact that no nation completely controls it border against smuggling of other commodities. Under a Department of Energy Program entitled the "Cooperative Border Security Program," efforts are underway to assist nations to meet their responsibility to prevent cross border movement of WMD materials through more effective border control. Countering all smuggling activities ensures countering WMD smuggling, and the solution will be used on a daily basis. This program applies a systems analysis process to a demonstration sector of their border in order to determine an effective mix of tactics and technology, implements the solution as a pilot program, and then provides the analytic tools and training in a capacity building process to the host nation. An overall systems analysis process leads to a complete system solution, including organizational structure, personnel training, border control structures, communications systems, border control tactics, intelligence operations, etc. This paper focuses on a subset of the problem – those functions performed by the border police organization along the border itself, beginning with detection and continuing through interdiction of the smuggler.

ANALYSIS PROCESS

The border security problem is basically one of detecting an illegal crossing and then interdicting the crosser. Borders are not homogeneous, but they can be subdivided into sectors with consistent terrain characteristics. This is meaningful to analysis as detection and interdiction abilities are heavily influenced by the nature of the terrain, and an effective solution in one sector may not be appropriate in others. Other methods of segmenting the border, by border police organizational structure for example, are less useful. An initial pilot sector should be selected that is important to the host country and will serve as a convincing demonstration.

Data Collection

The first step is to gain an understanding of the border environment and current situation. The best method is on the ground – to visit the border of interest and to interview as many members of the border security force as possible. It's extremely important to interview at many levels, as commanders and supervisors have one perspective, while operational personnel may have a completely different view of the situation. It also is necessary to gain the trust of the interviewees, which requires a significant time investment with them.

A less satisfactory method is to collect data from reports, observations, and interviews by third parties. As each third party observer sees the problem somewhat different, the results are disconnected and different pictures must be reconciled to develop the actual situation.

Data can be categorized into three areas: Terrain, Threat (smuggler), and Border Police. Terrain data includes standard information on slope, soil types, vegetation, waterways, road networks, built up areas, etc. – but it also includes effects of climate and weather on both smuggler and border police operations. In addition, terrain information includes clutter: which means civilian population distribution, normal vehicle and foot traffic, civilian cooperation with smugglers, etc. In other words, terrain data is the playing field for both smuggler and border police. Threat data includes smuggling organizations, origin and destination of contraband, normal smuggling routes, modes of transportation, tactics, willingness to employ violence, etc. Border Police data includes their organization, equipment, location of fixed facilities, operations and tactics, capabilities, and impact of their culture on their effectiveness.

A useful data collection tool is the task decomposition tool described in a following section. It outlines areas of discussion in a manner that will later feed directly into the analysis.

Analysis Process Flowchart

Analysis consists of several discrete processes that interlink to form a measure of border control effectiveness. The flowchart shown in figure 1 is divided into the three areas used in data collection: analysis of the smuggler (shown in red), analysis of terrain (shown in red where examined from the smuggler's use of the terrain and shown in blue where reflecting border police usage), and analysis of the border police (shown in blue). The various processes are connected to show how the product of one analysis impacts others.

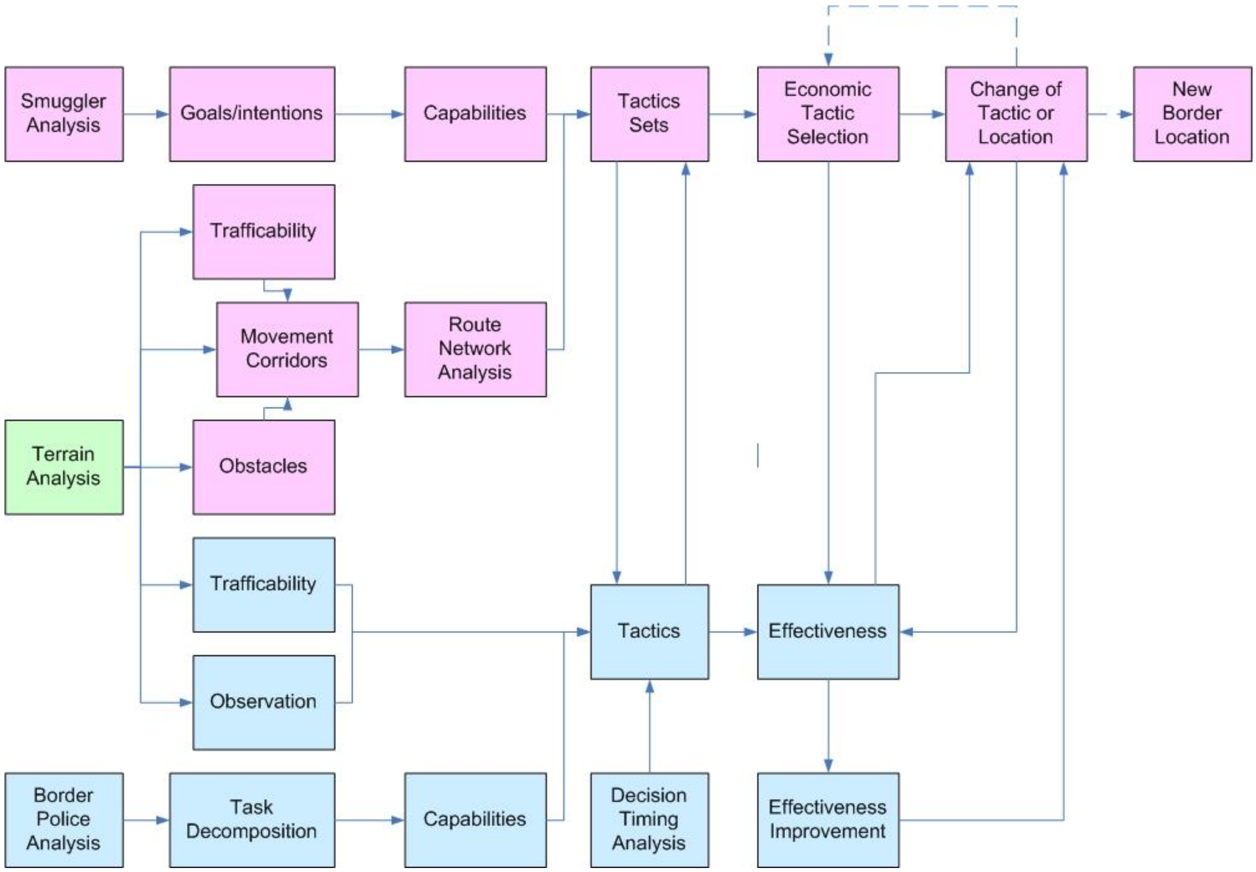


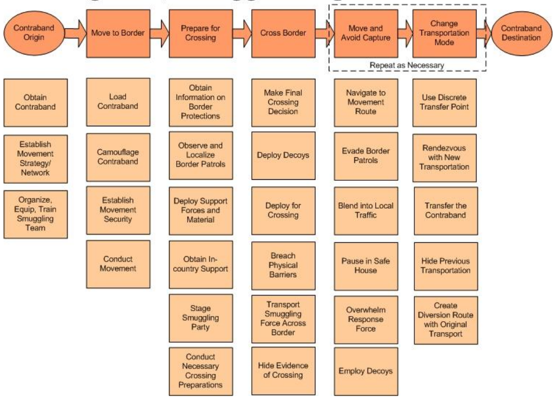
Figure 1, Analysis Process Flowchart

Smuggler Goals, Intentions, and Capabilities

This is an intelligence function based on what has previously been observed and what is predicted from other intelligence indicators. The first step is determining smuggler goals and intentions, which basically provides understanding of the smuggling mission and the limits under which they will operate. Goals and intentions will normally vary according to the smuggled commodity – for example, a smuggler moving terrorist materials or WMD components will normally pick the lowest risk route to a safe house or drop off point while being willing to employ a high level of violence in order to achieve his goal. A smuggler moving counterfeit cigarettes will have a high volume distribution system into which to move his contraband, yet will be willing to pay bribes or fines with little or no violence. This assessment identifies the destinations where the contraband will be delivered, and also is used to determine the amount of force needed by the border police for the interdiction.

As the smuggler must accomplish a number of sequential functional steps to achieve his goal, a step assessment tool is used to examine his capabilities. It serves as a guide for seeking data either through Border Police interviews or intelligence systems, and determines the composition of the smuggler set of possible tactics.

Figure 2, Smuggler Step Assessment



The tool (figure 2) begins with a listing of necessary sequential objectives for the smuggler as the contraband is transported across the border and to its destination. A series of methods which could be employed to accomplish each outcome are listed, and then each method is further broken down into specific required capabilities. Those capabilities either observed or considered possible are then identified; considering motivation, technology level, training, and resource availability.

Smuggler Terrain Considerations

Terrain analysis is a method for identifying how the terrain can be exploited by either a smuggler or the border police. Both sides will base their tactics and operations on their understanding of what the terrain will support.

The smuggler must pass through the border region without being interdicted. To accomplish this, his plan is based on following specific routes along selected movement corridors. These movement corridors are identified from the trafficability of the terrain and any obstacles to movement. The smugglers means of movement must be considered, whether vehicle, pack animal, foot traffic, or watercraft. A map study determines where there are obstacle to each of the possible modes of transportation, and where cross country movement is limited. Combined trafficability and obstacle map overlays are developed for each mode by shading out both the obstacles and the areas where movement is not possible due to steep slopes, water, and vegetation – the remaining areas are suitable for smuggler movement.

Movement corridors are determined from the trafficability and obstacle overlays by joining areas where movement is possible, combining possible cross country movement areas with roads, trails, and waterways. Then, multiple-mode movement corridors are developed by combining trafficability overlays noting locations where the smuggler can change from one transportation mode to another.

Routes then are developed linking smuggling origins with destinations on all possible movement corridors. These routes may join each other at a series of junctions (nodes) where corridors interconnect allowing the smuggler choices in his movement. Route network analysis converts these interconnecting corridors into a network, determines the passage speed along each possible route, and determines the most likely routes.

Smuggler Tactics and Tactics Selection

A set (as complete as possible) of potential smuggling tactics is developed through a “red team” exercise. Each possible tactic combines smuggler capabilities and the characteristics of the terrain to accomplish the smuggling goal. A means to check each possible tactic is to model it in a conflict simulation such as ACATS (Advanced Conflict and Tactical Simulation)[1]. This allows the red team to conduct detailed "what if" analysis.

Border Police Tasks

The Border Police mission is dissected and examined through employment of a Task Decomposition Analysis. This begins by identifying all desired outcomes that affect the interdiction mission. Then tasks that are necessary or could contribute to each desired outcome are identified in a simple model as shown in Figure 3, where outcomes are in yellow, and associated tasks are in orange.

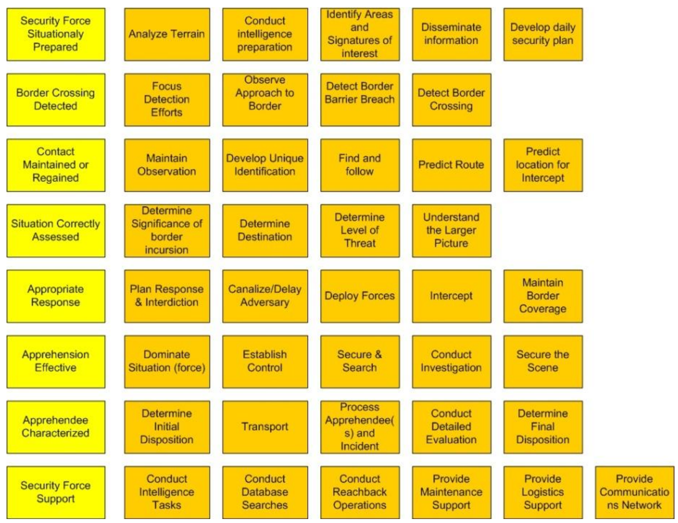


Figure 3, Task Decomposition

Tasks associated with each outcome are further decomposed into methods that might accomplish it. This then becomes the framework for collecting information on current capabilities as well as an outline to assist developing improvements.

Border Police Capabilities

Current capabilities are assessed for each of the methods; considering motivation, culture, rules of engagement, available technology, training, and resources. These capability assessments are annotated on the Task Decomposition framework. This is used to establish the current baseline for comparing effectiveness of potential improvements.

Border Police Terrain Considerations

The Border Police have two major considerations in use of the terrain; where they can observe and where they can travel. Observation areas or points are identified as high ground overlooking potential smuggling routes. If conducting a map study, elevation profiles are used to determine what each observation point can see, and where there is unobserved dead space. If using a simulation such as ACATS, this can be done semi-automatically by simply checking lines of sight from each selected location. Travel assessments look to the road network and terrain allowing high speed movement to determine routes the Border Police can use to rapidly reach potential interdiction or checkpoint locations on the smuggling routes. These are generally perpendicular to the smuggling routes. In addition, routes are determined along the actual border, where evidence of a crossing can be discovered.

Border Police Decision Timing

A key feature in a response strategy is the time it takes to execute the response. The OODA loop process examines decisions from observation to action.

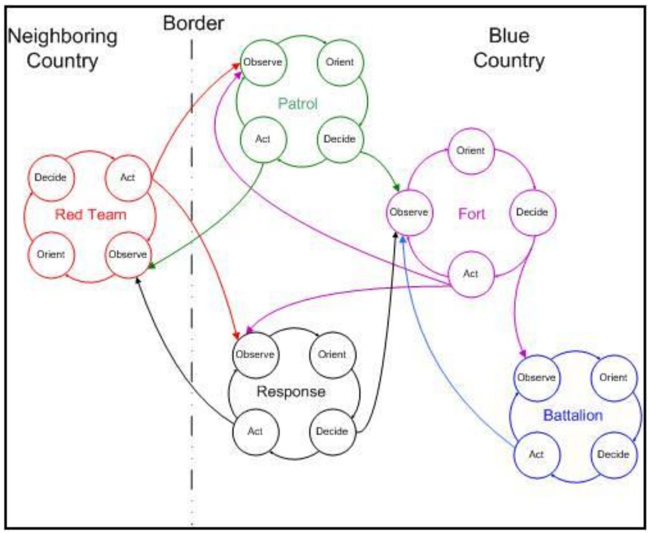


Figure 4, OODA Analysis

Figure 4 illustrates five interlinked OODA loops. Each consists of four steps: *Observe* (seeing something of interest), *Orient* (put in perspective and determine what it means), *Decide* (choose an appropriate action), and *Act* (initiate the action). Each step takes time, and has a probability for success. The four linked loops on the right of the figure show how a decision can be passed to a higher level of command – for example, the patrol sees something and decides to ask the fort for instructions, the fort asks the battalion, which then directs the fort to deploy a response force, which then has its own OODA loop before acting. Each level involved adds time to the decision process. In addition, as soon as the Border Police begin an overt action observed by the smuggler (the red team shown on the left side of the diagram), the smuggler begins his own OODA process to determine how to respond. A discrete event model is used to understand timing and uncertainty issues in the decision process, for both Border Police and smuggler. Since the Border Police operate in response to the smuggler's actions, the decision timing has a large impact on their effectiveness.

Border Police Tactics and Tactics Selection

As was done with the smuggler's tactics, a set of potential border police tactics is developed. Each possible tactic combines police capabilities and the characteristics of the terrain, aligned with the decision timing. Again, a virtual test bed (ACATS) is the most effective way to examine potential tactics. Initially this analysis quantifies the "as-is" state, using the current situation and assessing its effectiveness. Based on these results, improvements are made to the police efforts – initially only modifying their tactics, and then adding successively more complex technology until an acceptable effectiveness is achieved.

Smuggler versus Border Police Tactics

The virtual test bed is used to stochastically play out each potential Border Police tactical solution against each of the smuggler's tactics. When the best police solution has been determined to increase tactical effectiveness, the smuggler's tactics are then changed in response, and evaluated against the police solution. Various solutions composed of a combination of tactical and technological changes are tested to determine an optimum set for implementation. Tactical indicators are also identified for use in the decision process.

The final assessment uses an economics model to predict when a smuggler's response to more effective Border Police tactics is to shift operations by selecting another sector. It also identifies in priority, where he will most likely go.

Analysis Example

An example, based on a section of the Iraq-Iran border in the Maysan Marsh will illustrate the process. This particular border sector is selected, as it is an example of complex terrain as well as having been a smuggling avenue for thousands of years.

Task Selection

The critical outcomes for this sector analysis are those that directly impact detection and interdiction. Figure 5 highlights them: Border Crossing Detected, Contact Maintained or Regained, Situation Correctly Assessed, Response Appropriate, and Apprehension Effective. The associated tasks selected for each outcome are shown in orange.

Means to accomplish each task are then examined and alternatives selected. For example, the task "Detect Border Crossing" could be achieved by observers on border forts, or by a patrol "cutting sign."

Figure 5, Outcomes Selected for Analysis

Current Border Police Capabilities

The Border Police cannot effectively observe the border where it passes through the center of the marsh. They also cannot effectively interdict a smuggler within the marsh, due to the dense marsh grass and reeds. They currently have the bulk of their assets in forts along western edge of the marsh, with observation posts on forts and annexes spaced 4 to 7 kilometers apart.

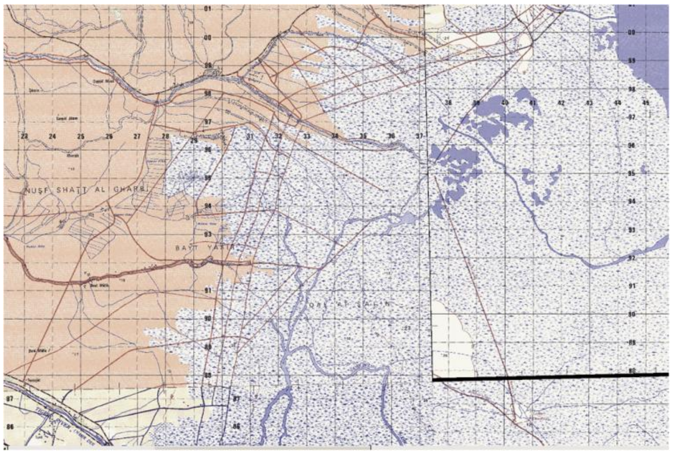


Figure 6, Maysan Area Map

Terrain and Road Network Assessment

The smuggler must use a canoe to transit the marsh, but then will transfer the contraband to a pickup truck to travel through the adjacent agriculture area. His intent is to reach the heavily trafficked major highway in the west and disappear into the background. As there is significant local traffic, he will use a common type of truck. As the local civilian boat traffic in the swamp will exit at controlled points adjacent to police forts, he will leave the swamp in between the forts. There is an extensive network of roads and trails through the agriculture area; however it all is located on the elevated network of levees or berms separating the fields – traffic across the fields is extremely slow and observable. Figure 6 shows the marsh on the right and the road network on the left. Figure 7 shows a schematic diagram of the road and trail network in the agricultural area. It consists of 120 road segments and is modeled in a network simulation to determine transit times to the various exit points (the major three are shown by the blue circles in the figure). Times to reach the three exit points ranged from 116 to 147 minutes.

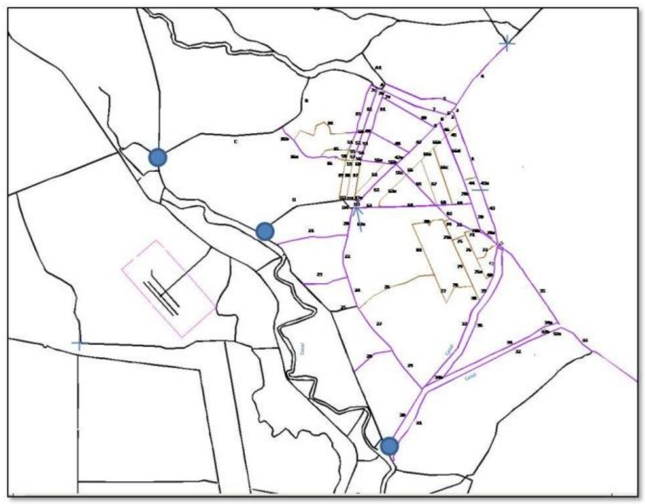


Figure 7, Road Network Diagram

Decision Timing Analysis

The Border Police culture limits the authority of the policeman, and requires all decisions to take action to be made by an officer at a higher command level. A decision model which linked patrol, fort, and battalion command levels applied an OODA loop structure with generous time estimates to determine action implementation timing. The schematic model is shown in figure 8. The model produced the following results:

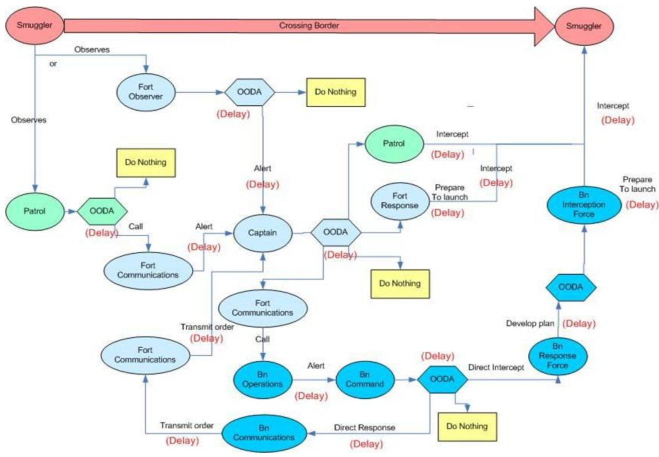


Figure 8, Decision Model

If the detecting patrol could decide to interdict, OODA delays resulting in 1.67 minutes until action; if the fort decided to have the patrol interdict, 6.65 minutes; if the fort decided to send a response force, 9.82 minutes; and if the battalion had to make the decision, 19.86 minutes. This means there is limited time after a decision for a forward patrol to react, especially if the decision is made at a higher level.

Virtual Solution Assessment

A set of possible solutions was developed, beginning with observers on the fort triggering a response force; then running a forward patrol along the edge of the marsh to observe either through direct observation or by seeing signs of someone exiting the marsh – with the battalion sending out an interdiction force; then adding a rear patrol on the road about 10 km back from the marsh, adding ground sensors at road critical road junctions; and finally, adding radar systems on the forts. Figure 9 shows the area of operations and the routes for forward and rear patrols in the ACATS simulation.

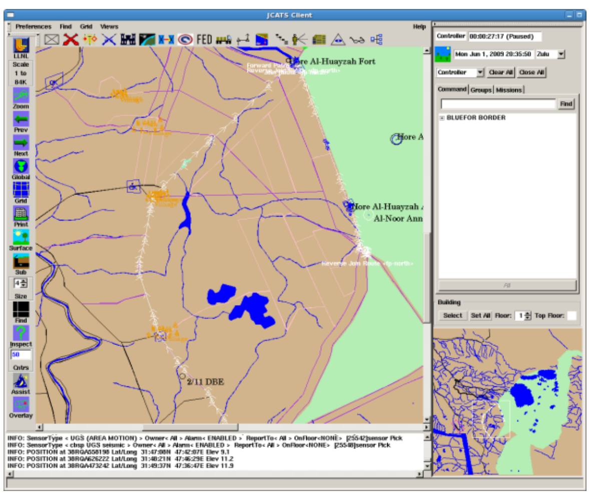


Figure 9, ACATS Simulation

A set of results for the case of the ground sensors is shown in figure 10. Five hundred simulation runs were conducted, and the histograms show the timing of captures by the forward and rear patrols. The probability of interdiction in this case was 74.4%.

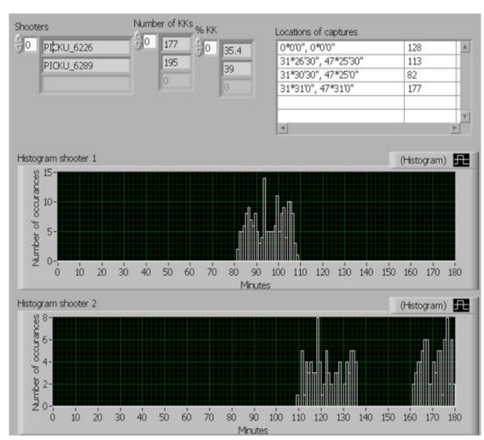


Figure 10, ACATS Data Analysis

The smugglers routes were varied stochastically. Decision timing delays prevented the police from reacting quickly enough to interdict if they didn't use patrols. The network analysis allowed precalculating highly effective interdiction points.

Analysis Results

The chart in figure 11 shows the results. If only observers with a response force from the forts were employed, there were no interdictions. If a forward patrol was employed, the smugglers were interdicted about 20% of the time. If a rear patrol were added, about 10 km back from the marsh edge, this improved interdiction to almost 40%. Adding ground sensors at key road network intersections pushed the interdiction to about 70%, while radar achieved about the same result for much higher complexity and cost.

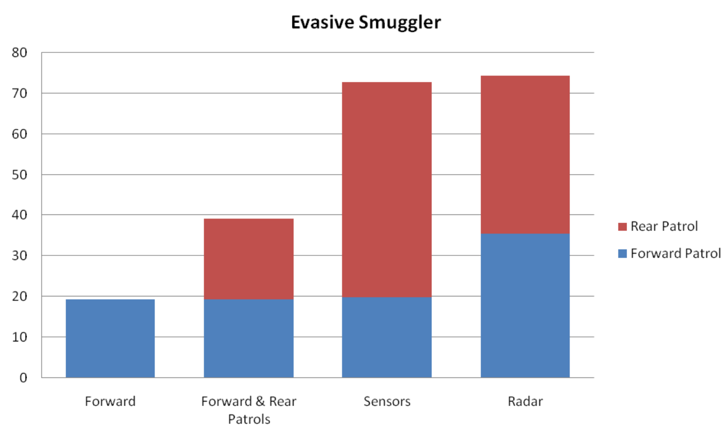


Figure 11, Analysis Results

Conclusions

The effectiveness of the border police requires study of their operational tactics, their decision processes, and the terrain. Solutions must combine CONOPS and technology; however, the solutions must match the level of technical sophistication of the border police. *No technology will be the "silver bullet." Finally, analysis models provide understanding – NOT answers!*

Ongoing Work

Current efforts are devoted to producing analysis tools and procedures not requiring complex software or computers. An export version of ACATS is the primary product; supported by a route network tool, decision timing and enhancement tool, and a detailed terrain analysis procedure.

As the smuggling problem is basically an economics problem, tools and procedures based on economics are under development. The first difficult problem being addressed is predicting smuggler actions with insufficient data. Algorithms developed for credit scoring are being examined – as the credit scoring system uses a very few indicators to predict future behavior, which is exactly the problem on the frontier border.

[1] ACATS, Advanced Conflict and Tactical Simulation, an enhanced version of the JCATS software developed by Lawrence Livermore National Laboratory for the Joint Forces Command, Department of Defense.

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