ICCRTS Tracking #094

RETHINKING INTELLIGENCE FUSION

by

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January 2015

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The views expressed in this paper are those of the author and do not reflect the official policy or position of the US government or the Department of Defense.

ABSTRACT

The modern battlefield is more complex than ever: layers of camouflage mask deadly threats, secure communication networks obscure enemy intentions, and mobile systems complicate targeting processes. Paradoxically, analysts must sift a growing deluge of data to derive “decision-quality” assessments. Traditional practices must be reworked to keep pace.

Using time-dominant fusion techniques, Airmen leverage cloud-based tools to speed correlation of vast quantities of multi-discipline information, including social media, with real-time collection. They optimize intelligence platforms by analysis closer to the point of collection. This enables proactive sensor posturing and dynamic collection plan updates.

Just as rapid intelligence analysis is a critical enabler of command and control (C2), so too is flexible C2 a critical enabler of responsive collection. Doctrinal processes divide intelligence tasks into discrete line items disassociated from the actual intelligence question, slowing both analysis and decision-making. Employing a problem-centric tasking model forces direct collaboration and shared understanding which, in turn, speeds analysis, clarifies communications, and accelerates decision-making.

Addressing modern threats requires redefining the approach to intelligence tasking and analysis. Optimizing collection is reliant on improving access to data, leveraging new intelligence sources, shifting analysis closer to collection, and empowering intelligence organizations at lower levels.

INTRODUCTION

Intelligence, Surveillance, and Reconnaissance (ISR) employment is fundamentally flawed; it is based on age-old processes that cannot keep pace with the modern battlefield. If recent conflicts in Libya, Syria, and Ukraine have proven anything, it is that modern battlefields are more complex than ever before. Equipment moves around the battlefield at a blistering pace; finding and fixing it requires dynamic ISR collection, rapid intelligence fusion, and responsive command and control (C2).

Current ISR methodologies have roots in the philosophy Colonel John Warden III. He sought to break complicated enemies into simple line items that, if properly targeted, resulted in strategic victories. Similarly, current ISR employment attempts to break complex intelligence problems into discrete tasks that, if properly collected, result in battlefield awareness. The limitations with these processes are exacerbated by the Air Tasking Order (ATO) cycle that relies on end users to predict extremely specific intelligence tasks days ahead of time and then expects them to assemble the disaggregated pieces after the fact. Air power, and ISR more specifically, has morphed into a process-driven exercise where perfecting the process perfects the result. In the past, this process may have worked well against fixed facilities easily monitored by intelligence collectors, but modern warfare is not so simple.

The Scud hunt during the Gulf War in 1991 illustrates the complexity of modern warfare. As an existential threat to Israel, Iraq's Scud missiles were top priority targets. The coalition used Soviet exercise doctrine to determine detectable signatures of Iraq's mobile launchers. When the Iraqis modified their prelaunch procedures and reduce communications, static ISR processes could not keep up, resulting in not a single mobile Scud kill by air power.[i] To survive, the US Air Force must evolve. New surface-to-air threat systems, such as Russia's mobile S-400, can strike ISR platforms out to approximately 250 nautical miles and then move long before the ATO cycle is completed.[ii] Furthermore, enemies are adopting techniques that obscure easily detectable signatures. As a rudimentary example, taking repeated images of a known equipment depot is ineffective if the enemy simple moves or covers their equipment routinely. Solving these complicated problems requires a marked departure from the current way of doing ISR business. The impetus for change lies in the need for flexible ISR as the standard against dynamic battlefields. In other words, effective C2 relies on responsive ISR, just as effective ISR relies on responsive C2.

DEDUCTIVE AND INDUCTIVE ISR

At its core, ISR is an exercise in reasoning, of which there are two basic types: deductive and inductive. With deductive reasoning, one attempts to prove a conclusion using sound arguments.[1] General theories are developed and then evidence is sought to prove them. Put another way, deductive reasoning is a big-to-small approach, like that shown in Figure 1. This set up forces analysts to look for activity that proves or disproves previously assessed enemy actions. Just as changes in Iraqi Scud tactics did not match expectations, the waves of anonymous soldiers seizing airports and government buildings in Crimea during February 2014 did not prove preconceived notions about how a Russian invasion would appear. As a result, decision-makers could not react quickly enough to counter the hostilities. The deductive approach is flawed because it presupposes the enemy's course of action and limits analytic flexibility.

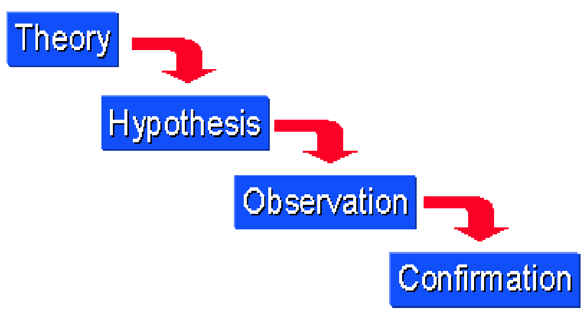

Figure 1: Deductive reasoning[iii]

[1] In *Critical Thinking*, Moore and Parker note that a deductive argument is valid if it is impossible for the premise to be true and the conclusion to be false. Sound arguments are those where the premise is, in fact, true.

Modern ISR employment standards exemplify deduction. The ATO process[2] itself is designed to break complex theories about enemy activity into ever more discrete tasks that, if executed properly, will definitively demonstrate the assessed courses of action. Using the Crimea example above, ISR operated under Cold War era premises that “if Russia is invading a country, they will use tanks” and “if Russia uses tanks, they will move from their garrison.” These premises led to the conclusion that “if Russia is invading a country, tanks will move from their garrison.” The premise is valid, but not necessarily sound. The overarching intelligence problem in this case would be determining whether or not Russia was invading, but ISR tasking would result in monitoring tank garrisons. The issue is worsened by requirements for end users to disassemble intelligence problems into source-specific tasks to facilitate ATO production, i.e. collection decks. The impact is three-fold: first, end users must develop very specific indicators to monitor well ahead of collection events; second, collection platforms and their associated analysts may not understand the full intelligence problem they are working to solve; and third, the onus for reassembly of resulting collection is pushed end users, slowing decision-making.

The decision-making process can be sped by applying inductive reasoning, which enables analysts to derive assessments based on a holistic look at activity on the battlefield. With inductive reasoning, the model described above is turned on its head. Specific premises are used to support, not necessarily prove, general conclusions. This small-to-big method, characterized in Figure 2, derives patterns from small observations to develop theories based on the strength of supporting evidence. Put simply, activity drives assessments; assessments do not drive activity. In Crimea, analysts may have developed a theory based on small indicators. Premises including,

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[2] Per Air Force Doctrine Annex 3-0, the ATO cycle consists of objective and guidance, target development, weapons allocation, ATO production, ATO execution, and assessment.

“Russian military activity along a country’s border is increasing,” “unidentified armed men are arriving outside government facilities,” and “Russian-made equipment, though not necessarily tanks, is being reported inside another country” drive the conclusion that “Russia is probably preparing an invasion.” The conclusion is not unequivocally true, in this example, Russian-made equipment may be prevalent throughout the region and they may be simply preparing an exercise. However, analysts were freed to make an assessment based on a holistic look at activity rather than narrowly focusing on one indicator, such as tank deployments.

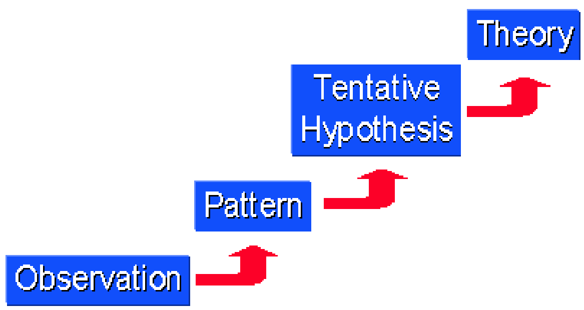

Figure 2: Inductive reasoning[iv]

While deduction may overly bound intelligence problems, induction may open them to a fault. It is important to note that the inductive approach is reliant on a broad definition of the intelligence problem, but it differs from deduction in that the answers or means to get to them are not prescriptive. The difficulties with induction are efficiently sifting through the sheer volume of potential indicators, especially given the multitude of ISR sensors available today, to form a coherent theory of activity on the battlefield and enabling C2 to action said theory. The solution to the former is effective intelligence fusion; the solution to the latter is adaptive C2 mechanisms.

CHALLENGES OF BIG DATA

The challenge of induction is in making sense of a deluge of information that cannot be reasonably processed or analyzed using traditional methods, otherwise known as big data. By unlocking the potential of big data, analysts are able to identify patterns of behavior never-before accessible and can make assessments with increasing speed and accuracy. The concept of big data is characterized by what are known as the three Vs: volume, velocity, and variety.[v] Occasionally a fourth "V" of veracity[vi] is added.

Volume describes the total amount of information available to users, either in terms of programs or people. The number of intelligence sensors employed throughout the world has increased exponentially since the Cold War. As an example, the USAF's MQ-1B Predator fleet has risen to a staggering 164 since reaching initial operational capability in 2005.[vii] Analysts must cope with the amount of information coming off of all the associated sensors employed.

Velocity explains the speed with which data flows to users. In terms of intelligence, this means that analysts may have increasing access to reams of raw or pre-processed data as it is collected rather than having to wait for other agencies to produce finished products. The rapid assessments required to function on a dynamic battlefield rely on a timely information flow.

Variety encompasses the diversity of big data. As Edd Dumbill notes in "What is Big Data," the challenge is that data "could be text from social networks, image data, [or] a raw feed directly from a sensor source. None of these things come ready for integration" and analysts must make sense of it all.

Veracity defines the "quality and provenance of received data".[viii] Intelligence analysis is based on shades of grey and data used to make assessments must be evaluated to determine it accuracy. By increasing sample sizes and expanding sources, analysts can better identify and mitigate problems with data.

Practical use of big data is reliant on effectively dealing with issues of volume, velocity, variety, and veracity through fusion. The Air Force's Deputy Chief of Staff for ISR identifies three elements resident in programs that enable big data fusion: 1.) Large volumes and varieties of data are collected from multiple sources, tagged, and stored in an information cloud; 2.) Applications are developed allowing analysts to manipulate, visualize, and synthesize data; and, 3.) Analysts' operations are captured and continuously added to the cloud.[ix] Today, analysts have access to cloud-based tools, such as Joint Enterprise and Modeling Analytics (JEMA), which allow them to model and automate iterative processes required for processing, sorting, and displaying large volumes of data from a multitude of sources. When combined with powerful geospatial tools, e.g. Google Earth, analysts can easily view data spatially or temporally to simplify analysis.

However, perhaps more important than programming elements are the characteristics of personnel tasked with employing them. In *Building Data Science Teams*, DJ Patil finds four defining traits of people optimized to exploit big data: technical expertise, curiosity, storytelling, and cleverness.[x] All four are defining characteristics of young Airmen who grew up surrounded by technology, who naturally desire more information (e.g. the tendency to "Google" topics mid-conversation), who leverage countless communications means, and who are capable of looking at problems in new and different ways. Embracing big data fusion is as simple as creating an environment in which these Airmen can thrive rather than tying them to stale models or stove-piped collection decks.

INTELLIGENCE FUSION

Making sense of big data is really a problem of intelligence fusion, a function that is critical to combatting a modern adversary. In its most basic form, fusion is the process of combining multiple sources of data to provide a complete picture of activity on the battlefield. By looking at a broader base of activity, analysts are able to identify signatures that may not otherwise meet reporting thresholds. The importance of using multiple data sources is especially obvious in the example of Russia's takeover of Crimea where Soviet principles of maskirovka, or integrated deception, were employed to hide Russia's true intentions. Traditional ISR practices could not provide adequate tactical warning to enable a proactive NATO response. Once the invasion started, the so-called "little green men" who led the seizures of government facilities could not be undeniably tied to Russia, or any other country for that matter, which further slowed international responses. In any case, attribution may not always be possible using solely "traditional" intelligence sources, requiring the implementation of big data-driven sources such as broadcast news or social media.

More specifically, maskirovka is a process "designed to mislead, confuse, and interfere with accurate data collection regarding all areas of Soviet plans, objectives, and strengths or weaknesses" to slow enemy decision-making.[xi] Maskirovka incorporates a variety of concepts ranging from simple camouflage paint to demonstrative action or feints across all levels and branches of the military. The full scope of maskirovka is evident in operations such as Operation BAGRATION in 1944 in which the Soviets killed 500,000 Germans and overwhelmed 117 divisions by surprising the Germans from a swamp, when the Germans had expected them to use roads.[xii] Had the Germans fully understood maskirovka, they may have seen distinct indicators of deception, such as a lack of resistance along the main lines of communication. The answer to maskirovka, whether executed by the Russians in Crimea or ISIL fighters in Syria, is fusion. By varying capabilities and increasing the sample size, correlating multiple data sources can mitigate the limitations of each individual sensor.

Fusion itself is divided into two categories: content-driven analysis and time-dominant fusion, described by in-depth in "Time Dominant Fusion" by Major Amanda Figueroa:

> Analysts [performing content-driven analysis] nearer to policy-makers provide an understanding of the overall environment in which forces are operating…They communicate what is known about adversary doctrine, training, culture, armament, seasonal weather effects, and a myriad of other considerations and the effects those considerations have on the battlespace at a macro level. Additionally, analysts close to policy makers play a key role in identifying the commander's priority intelligence requirements (PIRs), questions whose answers will lead to decision points.
>
> Analysts [conducting time-dominant fusion] in close proximity to sensors take the articulated commander's intent for ISR and the contextual analyses provided from the policy level and apply them to mission operations, adjusting as required to the realities of any given day. It is because these analysts have a contextual baseline from which to begin that they are able to rapidly identify events which signal the adversary is operating in a different manner than expected…quickly flag the activity, cross-cue to other sensors for multi-INT collection, and provide a rapid, fused assessment of the activity.[xiii]

The critical task of time-dominant fusion, then, is inductively linking specific observations in the environment to assess the likelihood an enemy is deviating from their baseline activities. Part and parcel to this is integrating new intelligence sources, dealing with the associated data, and using rapid assessments to drive operations.

Countering complex adversaries requires overcoming sensor limitations by incorporating new data sources to supplement collection. Intelligence analysts are constantly looking for detectable signatures, and systems that are sufficiently mobile, camouflage, or silent do not present clear indicators, especially against static collection decks. Even the venerable U-2S Dragonlady spy plane, which is capable of simultaneous geospatial and signals intelligence, is limited in terms of total aircraft numbers and sensor capabilities, making each sortie precious.

Optimizing these missions begins with an in depth understanding of the operational environment, enabled by content-driven analytic organizations, such as the National Air and Space Intelligence Center. Their studies produce an assessment of baseline activity and recommend ideal sortie times or orbit locations. More specifically, these studies integrate collection from airborne platforms, satellites, and open source to derive their assessments.

Open source is perhaps the most exciting of new data sources. Historically, open source reporting has been limited primarily to newspaper reporting or broadcast news. These platforms contain a wealth of information, but are difficult to process. Simple key word searches of news articles or transcripts yield basic information about overall content and atmospherics, but care must be taken to identify false reporting, e.g. propaganda from state-owned media. Newspapers or broadcast news also rarely specific enough locations or times to guide collection efforts. However, technological advances have changed the way that people interact with their world. People focus increasingly more attention online than on newspapers and news networks. As their online presence grows, a person's trail of digit breadcrumbs expands.

Social media is the most prevalent example of digital presence expansion. In fact, Facebook alone had over 1.3 billion users in the fourth quarter of 2014.[xiv] Interestingly, social media sites provide analysts with free intelligence without the need for covert collection techniques. And, as General Frank Gorenc remarked, "people underestimate the importance of social media."[xv] Take an online clothing store, as an example. Storeowners would be interested in how their products were being received by customers. Using simple, online tools they could analyze traffic to and from their website with excruciating levels of detail, including IP address, browser type, referring site, and products viewed. All of that information could be used to specifically modify or target their content. The storeowners could also assess the social media landscape by searching for mentions of their product in posts, which would allow them to gather candid feedback. Known customers, or even target demographics, could be closely followed for indicators of market preference. Presumably, even a small portion of posts would contain geo-tags, or specific locations, indicating where individual users were located. Consolidation of geo-tags from multiple users would give insight into customer demographics, especially when combined with other data, such as population levels, crime, median income, etc. to provide analytic context. Again, none of this information requires special techniques to gather; users freely offer it.

While a treasure trove in itself, social media content is even more powerful when combined with other sources. Da'esh, the former al Qaida faction responsible for thousands of attacks in Iraq and Syria, has a massive online presence. Their public affairs arm is responsible for countless Tweets, YouTube videos, and infographics detailing operational outcomes.[xvi] Even posts from out of garrison tank operators, to refer to the earlier Russia examples, may indicate deployments—part of the reason US operations security is so strongly emphasized. These posts can quickly confirm or deny low confidence assessments based on other, more traditional sources. If an adversary successfully counters "normal" intelligence sensors using maskirovka techniques, why not use their own data against them to mitigate the impacts? This is a key enabling function of big data fusion led by innovative Airmen.

If Airmen are able to harness the power of social media, how will they use it to rapidly inform decision makers? First, social media will be used as an additive fusion layer to be incorporated into foundational intelligence preparation of the operational environment. This content-driven analytic function is a critical component of putting limited ISR assets in the right place at the right time. Second, it will be used by time-dominant fusion entities to rapidly correlate collection and increase the fidelity of assessments. And third, it will be used to identify deviations from known patterns of life that may indicate adversary actions before traditional sensors can be repositioned. C2, however, must be adapted to take these inputs and respond quickly enough to catch the enemy in the act.

ENABLING COMMAND AND CONTROL CONCEPTS

As illustrated above, ISR must be responsive in order to operate against a modern adversary. In reality, there are two concepts to address: ISR for C2, addressed above, and C2 of ISR. ISR is the only USAF core capability that has a symbiotic relationship with another; better ISR results in better C2, just as better C2 results in better ISR.[xvii] Current C2 processes, such as the ATO cycle, are simply not fast enough to respond to real time developments on the battlefield. In fact, entirely new processes, such as ad hoc collection, [3] have been implemented to make up for an ATO's shortcomings. Ad hoc collection, in particular, undercuts Air Force Doctrine Annex 3-60's assertion that "following the collection plan leads to detections."[xviii] Some argue that the reason ISR is unresponsive is because the process is imperfectly implemented. If only execution were better, the ISR results would be too. In reality, the world changes too quickly for the ATO; the real problem lies in the industrial-age process itself.

Current models are inherently limited because they emphasize rigidity over flexibility, sometimes termed process warfare.[4] The Warden method is a prime example of process warfare. He argues that successful strategy requires simple modeling of the enemy from which centers of gravity can be identified and then necked down into specific targets for action. Impacting the right centers of gravity will cause strategic paralysis. [xix] The ATO cycle is essentially the same. In ISR, supported units must take complex intelligence problems, develop narrow requirements, and generate source-specific tasking. Simply collecting the right targets enables perfect

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[3] Ad hoc targets are those that are added to collection decks after the ATO has begun execution. The approval chain for ad hocs ranges from minutes to hours, as opposed to 72-96 hours.

[4] Colonel Jason Brown describes process warfare as a reliance on executing specific procedures as a means for winning in combat; it is the antithesis of innovation and flexibility.

knowledge of the adversary. These processes may work in a static, strategic context, but they are ineffective in dynamic environments.

Warden's Rings do not account for shifting enemy landscapes characteristic of today's battlefields. Thanks, in part, to technological advances, targeting a center of gravity causes the entire system to react. Once the enemy system changes, the model is invalid. ISR employment faces the same challenge. One cannot expect that a highly specific collection deck developed over 72-hours will account for troop movements on the battlefield. Noting an insufficient collection deck and simply trying harder during the next evolution is the current, ineffective method. If a key feature of combating modern adversaries is moving to an inductive approach, then C2 must radically shift away from their process-centric, deductive roots.

Changing the prescriptive process is simpler than it seems at first glance, but it involves delegating additional authorities to lower levels. The availability of "Pred Porn" on every computer has allowed strategic- and operation-level leaders to become deeply involved in tactical-level decision-making, effectively stifling innovative mission commanders with over centralization. Lieutenant General David Deptula points out that centralized control, decentralized execution[xx] must evolve to centralized command, distributed control, and decentralized execution as an "appropriate progression towards more agile, flexible C2 in an era of increasing threats and accelerating information velocity."[xxi] By empowering lower echelons, commanders can create a thinking organization. Rather than relying on stove-piped collection decks, ISR operators will be given effect-based tasking allowing them to optimize their platforms based on purpose and intent. They will fuse information to posture sensors and will collect new indicators from which they can derive robust assessments.

The most common effects-based tasking construct is the mission type order (MTO),[5] which is generally only employed for short-duration operations involving a multitude of assets. The primary benefit of an MTO is that it does not force a supported unit to use the ATO cycle, at least not in the traditional sense, to accomplish their mission. They are not required to distill their intelligence problems into source- or platform-specific collection decks, allowing each asset to optimize their sensors based on a full understanding of their task. This mutually supports both content-driven analysis and time-dominant fusion processes. Put another way, end users establish all encompassing questions and empower ISR units to seek specific indicators from which they can derive answers. Furthermore, an MTO ties supported units directly to their supporting assets which ensures that information flows to the right person.

An MTO also, normally, establishes a distributed control authority. With the freedom to modify sensor employment at the tactical-level, an MTO slashes ISR reaction times by eliminating the need to constantly revalidate collection requirements with higher echelons. Non-traditional indicators, including social media trends, can be easily incorporated into collection planning. Normalizing MTO concepts, in short, inverts "the paradigm of large, centralized theater C2 nodes and develop[s] a system that issues specific direction to… multiple nodes responding in parallel"[xxii] to solve complex intelligence problems. It should be noted that an MTO is not necessarily freestyle ISR; they are scoped with key intelligence questions, but not prescriptive tasks. An MTO, though, opens the process to allow C2 operators, collection platform crews, and analysts to find innovative problem solving methods. In fact, if one were to redefine C2 of ISR, it would look remarkably like an MTO.

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[5] According to Joint Publication 1-02, a Mission Type Order is an order to a unit to perform a mission without specifying how it is to be accomplished.

CONCLUSION

The basic mission of any ISR operation is to provide the right information, to the right person, at the right time. However, current ISR processes create substantial roadblocks to the "three rights."[xxiii] Specifically, the focus on static target decks prevents analysts from seeking out activity-based intelligence indicative of adversary action (the right information). Disaggregation of ISR tasks distances analysts from their customers and the intelligence problems they are trying to solve (the right person). And finally, rigid process-centric operations restrain otherwise responsive capabilities, potentially keeping critical intelligence "on the rail" (the right time).

Modernizing the Air Force's ability to address activity-based intelligence relies on opening analysts' aperture. An inductive approach to ISR tasking allows for creative problem solving. Analysts can leverage new capabilities and data sources to identify detectable signatures that might otherwise go unreported. By framing tasking in problem-centric terms, supported unit processes are simplified and ISR platforms are freed to optimize their capabilities. Problem-centric ISR tasking, exemplified by the MTO construct, leads to ownership of problem sets. Bookended by content-driven analysis, analysts performing time-dominant fusion are directly tied to their customers and can actually drive collection and subsequent decision-making. In short, the Air Force must do three things: 1.) Enable inductive analysis by eliminating prescriptive ISR tasks, wherever able; 2.) Develop big data analytic tools and empower Airmen with increased training in analytics and information technology; and, 3.) Revamp the ATO cycle using a problem-centric, responsive approach, such as an MTO, as the model.

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[vii] (US Air Force 2010)
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[x] (Patil 2011)
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[xii] (Ash 2015)
[xiii] (Figueroa 2014)
[xiv] (Statista.com 2015)
[xv] (Gorenc 2015)
[xvi] (Matthews 2014)
[xvii] (Stone 2014)
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[xix] (Warden III 1995)
[xx] (Curtis E. LeMay Center for Doctrine Development and Education 2011)

[xxi] (Deptula 2014)
[xxii] (Deptula 2014)
[xxiii] (Vernal 2015)